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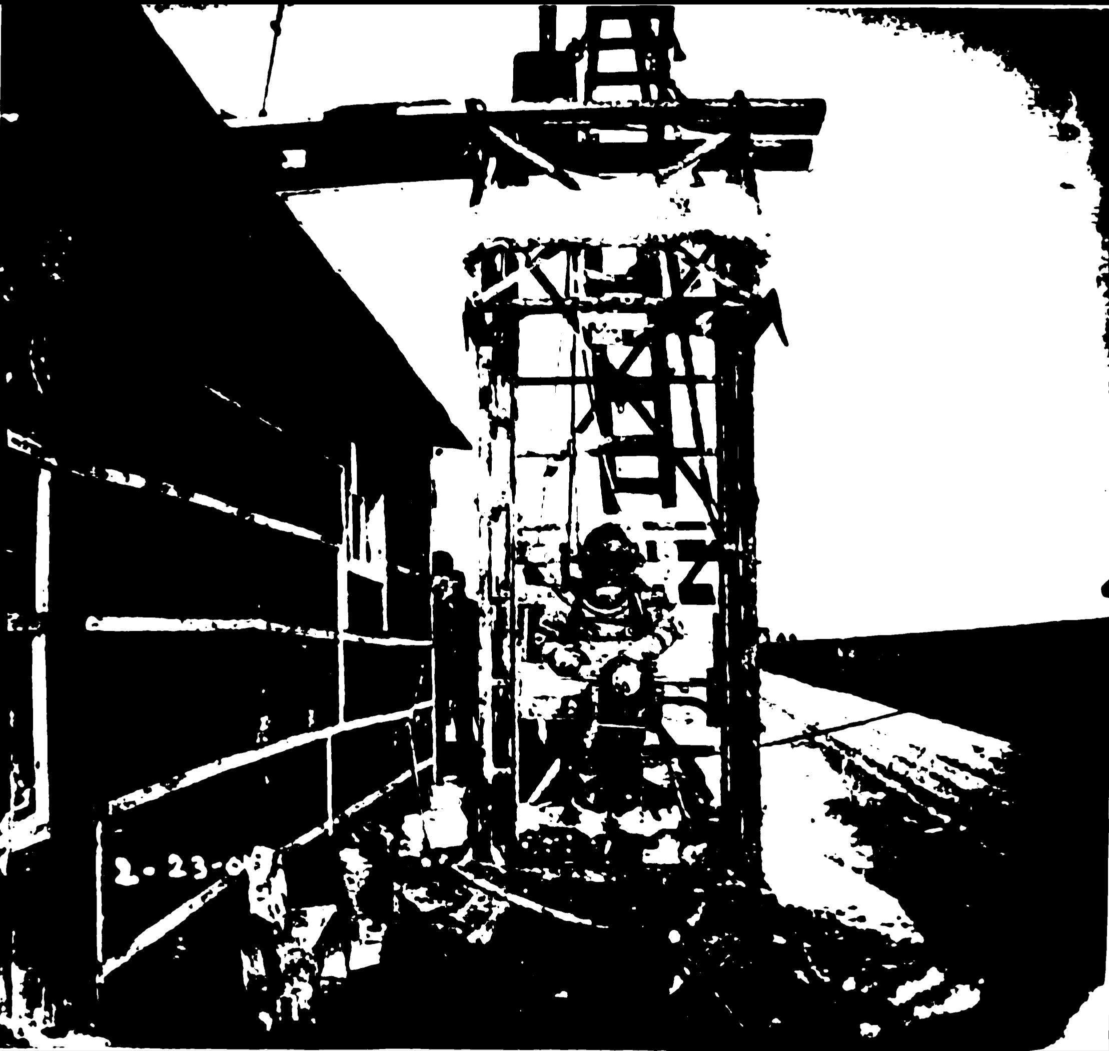
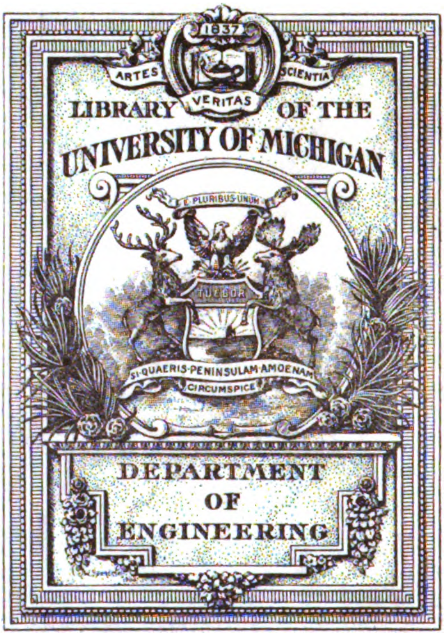


Report of the chief of engineers U.S. army

United States. Army. Corps of Engineers,
United States. Mississippi River Commission



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OF THE

WAR DEPARTMENT

FOR THE

FISCAL YEAR ENDED JUNE 30, 1901.

REPORT OF THE
CHIEF OF ENGINEERS
PART 4.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1901.

APPENDIXES

TO THE

REPORT OF THE CHIEF OF ENGINEERS,

UNITED STATES ARMY.

(CONTINUED.)

C 134348

APPENDIX G G.

IMPROVEMENT OF OHIO RIVER.

REPORT OF MAJ. WM. H. BIXBY, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1900, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Ohio River.
2. Operating snag boat on the Ohio River.
3. Operating and care of Davis Island Dam, Ohio River.
4. Movable dams in Ohio River.
5. Survey of Licking River, Kentucky.

EXAMINATION AND SURVEY.

6. Ohio River at Maysville, Kentucky.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, July 20, 1901.

GENERAL: I have the honor to transmit herewith the annual reports of the works under my charge for the fiscal year ending June 30, 1901.

Very respectfully, your obedient servant,

WM. H. BIXBY,
Major, Corps of Engineers.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

G G I.

IMPROVEMENT OF OHIO RIVER.

In the Annual Report of the Chief of Engineers for 1896, Part IV, pp. 2062–2063, is a general statement of the condition of the river, drainage area, population, commerce, etc., and the methods applied for its improvement.

Much of the information contained in the tables below relating to the commerce of the Ohio River has been furnished by Mr. C. B. Murray, superintendent of the Cincinnati Chamber of Commerce. Some data were also supplied by Mr. J. Frank Tilley, assistant secretary of the Pittsburg Coal Exchange.

GENERAL IMPROVEMENT.

EMBANKMENTS, BANK PROTECTION, AND DIKES, CASEYVILLE, KY., 861 MILES BELOW PITTSBURG.

Under the appropriation for the general improvement of the river, a project was approved by the Chief of Engineers May 9, 1900, for the construction of a third dike at Tradewater Bar, below Caseyville, and near and below the mouth of Tradewater River, the dike contemplated to be about 1,400 feet in length, with a height of 6 feet and a width of 16 feet. Proposals for the work were opened July 5, and award authorized July 18, 1900, to Hampton G. Grainger, of Caseyville, at a cost of $12,855.

The contractor began work August 24, and in September completed pile driving for the entire length of the dike, except at the opening temporarily left near the Illinois shore for the passage of steamboats. The work of building up the dike continued steadily until November 27, when the stage of river became too high, and in view of the lateness of the season the contractor suspended operations.

Operations will probably not be resumed until late in the season of 1901, the prevailing stage of river at this locality in the earlier part of the year being too high to permit advantageous work.

A map[1] showing location and present condition of the dike accompanies the assistant's report, hereto appended.

Examination of dikes, dams, etc.—With a view to the repair of damage caused by ice and drift since the construction or last repair of the dikes and dams on the upper section of the river, a special examination was made in September and November of such works between Pittsburg and Marietta, where repair is considered most urgent, in order to take immediate advantage of favorable conditions when work becomes possible and necessary. The works examined included dikes and dams at twenty separate localities, as follows:

Miles below Pittsburg.	Location.	Kind of structure.
49.0	Bakers Island	Riprap dam at head.
52.0	Clusters Island	4 dikes and 1 dam.
58.0	Blacks Island	Crib dam at head.
62.0	Browns Island	Do.
70.0	Mingo Island	Riprap dam at head.
77.5	Beach Bottom Bar	Do.
84.3	Upper Twin Island	Do.
106.7	Captina Island	Crib dam at head.
111.5	Fish Creek Island	Do.
127.7	Fishing Creek Island	Riprap dam at head.
132.7	Williamsons Island	Do.
134.2	.....do	Riprap dam at foot.
138.0	Wells Island	Riprap dam at head.
140.2	Mill Creek Island	Do.
141.0	Grandview Island	Do.
146.5	Petticoat Bar	Riprap dam.
157.0	Three Brothers Island	Crib dam at head.
169.0	Marietta Island	Do.
169.0	.....do	Crib dam at foot.
180.0	Coles or Neals Island	Riprap dam at head.

Maps and reports have been completed of all the works named, showing condition of each when examined, with estimates of cost of raising riprap work to its original height and extending it to the adjoining bar or bank in such way as to prevent passage of water at a 4 to 6 foot stage above low water, and for restoring crib structures to their original condition.

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[1] Not printed.

As the reports on the dams at Browns and Marietta islands indicated immediate repair to be urgent, repairs were made as stated below. Maps[1] showing the dams in section as originally constructed and as repaired accompany the reports in detail, hereto appended.

Browns Island Dam, 62 miles below Pittsburg.—This work had been considerably injured, 1,200 linear feet of the lower half of the dam being almost entirely destroyed and washed out, the ties and paving on the upstream side rotted and broken, and the shore ends partially carried away. Repairs were completed in November, and a subsequent examination after high water appeared to indicate that no further work will be needed for several years.

Marietta Island Dam, 169 miles below Pittsburg.—The damage to this work consisted of a break about 550 feet long in the middle portion, where the filling and paving had been washed out, many ties and timbers gone, and the apron badly injured and partly displaced. The repairs were made in November and December by cutting down a part and rebuilding elsewhere, all material used being obtained from the portion dismantled. The work is now in condition to withstand ordinary injury from ice and freshets, and is high enough for present needs of navigation

DREDGING AND EXCAVATION.

United States dredges.—Owing to the unfavorable stage of river for work proposed at Mound City the dredges remained at Newport, Ky., until August 8, completing repairs and waiting for new machinery. They arrived at Mound City on August 16, and on the 21st work was begun by the dredge *Ohio*. Repairs on the dredge *Oswego* having been completed, and the dredging by the *Ohio* having been stopped on October 6 by high water, the fleet was moved to Brooklyn, Ill., for work in that harbor until a lower stage at Mound City would permit resumption.

Work at Brooklyn was continued until November 23, when stopped by a rapid rise in the Tennessee River, with indications of a general rise in the Ohio which would postpone dredging indefinitely. Operations were accordingly suspended for the season, and the boats taken to a safe harbor in the Tennessee River above Paducah. The hired towboat was discharged on the 26th, and the usual arrangements for the care of boats and plant completed on December 4.

During the winter office work was continued at Cincinnati in preparing specifications and contracts for two new dump scows and for necessary repairs to fit the dredges for the season's work. At the close of the year the finishing and fitting of steel castings for the dredge dipper and other machinery was completed and the parts ready for shipment.

The funds available for general work on the river being limited in amount, the dredging proposed is that provided by special allotments at Evansville, Ind., and at Golconda, Brooklyn, and Mound City, Ill. At these locations the stage of river is usually too high to permit work earlier than August 1, and the dredges have therefore remained in winter quarters at Paducah, but will be taken early in July to Evansville for repair and fitting out ready to resume work as soon as conditions permit.

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[1] Not printed.

Hillerman Landing, Ill., 939 miles below Pittsburg.—En route from Mound City to Brooklyn the dredges stopped at this point, and on October 11 removed a reef of cemented gravel blocks extending diagonally upstream from the lower end of the landing, dumping them outside of the channel in deep water.

Hired dredging plants.—The amount of dredging required at various localities on the lower river, and for which funds had been provided by special allotments, being greatly in excess of what can be accomplished by the Government dredges under the most favorable conditions, it has been necessary for several years past to employ two additional plants for such work, each plant consisting of one dredge, three dump scows, and a towboat as tender, provision being made by supplemental contracts for operating each plant with double or triple crews, for sixteen or twenty-four hours per day, when desirable or necessary.

The details of special dredging under special allotments at Madison, Evansville, Brooklyn, and Mound City are given below under the heading of "Special improvements."

During the season of 1900, the two plants in service under contract were furnished by William A. Kirk, of Madison, Ind., and H. S. Brown, of Quincy, Ill., the former being operated continuously in the harbor at Madison, Ind., from July 18 to November 28, and the latter at Evansville, Ind., from July 19 until September 25, when the special dredging at this place was suspended in order to comply with urgent requests of the various packet lines and steamboat interests between Louisville and Evansville for sufficient dredging to open low-water channels through the various sand bars on this section of the river. The boats arrived at Falling Run Bar, the point destined for beginning work, on October 1 and continued work until November 24, dredging to an average depth of 4 feet below low water, and for such width as necessary at the following bars, viz: Falling Run Bar, sand; Hughes Bar, sand; Boston Landing, sand; Richardson Landing, sand and gravel; Blue River Island Bar, sand and gravel; Oil Creek Bar, sand and gravel; Chenault Reach, mud, gravel, etc., and Fulton Bar, gravel and sand.

On its way down river the plant also removed snags and large stone at Boston Landing, Chenault Reach, and Cloverport, Ky.

Location of dredging, dumpage, etc., at Chenault Reach and Fulton Bar is shown on progress maps appended to assistant's report on dredging.

After the completion of work at Fulton Bar, on November 24, the plant returned to Evansville to resume dredging, but owing to high water had to be discharged.

Details of the above work are given in the report on dredging, hereto appended.

Licking Bar, 466 miles below Pittsburg.—Under subproject approved April 1, 1899, providing for the expenditure of $78,000 out of the appropriation of March 3, 1899, for general improvement, proposals were invited June 14, 1900, and opened July 19, for about $74,000 worth of work in the removal from this bar of about 16,300 cubic yards solid rock and 13,400 cubic yards loose rock.

The bidders to whom award was authorized having declined to enter into contract, new specifications were prepared and the work readvertised. The new proposals were opened October 31, but as the lowest bid greatly exceeded the cost of previous work by the Government, authority was given to reject all bids and to do the work by hired labor and open market purchase, and to make necessary repairs and additions to the Government drill plant.

The repair of the drilling plant, having been twice advertised without satisfactory result, w[illegible]warded under open market proposal, and the drill boat taken in May from winter quarters in the Kentucky River to Higginsport, Ohio, where it is now undergoing repairs. Plans for a light-draft dredge boat with a large grapple bucket are being prepared, and the blasting of the bar will begin as soon as the stage of river will permit advantageous work.

GENERAL CHANNEL DREDGING.

Surveys and maps prepared during the past year show the following dredging still necessary from Pittsburg to Cincinnati to give a good channel of 400 feet width and 1 foot depth at low water, and a good channel of the same width and coal-boat depth at early coal-boat stages, such channel being essential to coal-boat navigation until dams are built, and afterwards at times when the dams are first raised or lowered for the season.

As it is very difficult to find dredges at reasonable rates to work on the Ohio River where the rise and fall of river is very great and very irregular, and as work with the two United States dredges *Ohio* and *Oswego* has proved very advantageous and economical, it now appears exceedingly desirable to provide for continuous channel dredging on this river by doubling the existing plant and by making provisions for its permanent employ at a rate of $150,000 to $300,000 of work per year in the same way as the annual Ohio River snagging has been provided for (see section 13, act of September 19, 1890) and by making such appropriations available for construction of plant as well as for its operation.

A large plant is necessary because of the shortness of the season allowing operation of dredges (averaging only 5 months per year), and one-third of each annual appropriation should be available if necessary for construction and repair of plant.

Channel dredging specially needed for coal-tow service in Ohio River between Pittsburg and Cincinnati.

Miles below Pittsburg.	Name of bar.	Estimated cost at about $0.38 per cubic yard.
6	Horsetail	$8,000
6.6	Duffs*	9,000
8.7	Lower Trap	8,000
12.6	Deadmans Island	40,000
13	Little Sewickley*	8,000
18	Logstown	10,000
22	Wallers Ripple	17,000
25	Beaver River	9,000
26	Beaver	30,000
28	Vanport	38,000
32	Montgomery Island	42,000
35	Phillis Island	24,000
37	Georgetown Island	14,000
41	Line Island	40,000

Channel dredging specially needed for coal-tow service in Ohio River between Pittsburg and Cincinnati—Continued.

Miles below Pittsburg.	Name of bar.	Estimated cost at about $0.33 per cubic yard.
42.5	Babbs Island	$2,000
49	Bakers Island	44,000
51	Cluster Island	2,000
53	Blacks Island	10,000
60	Browns Island, head	6,000
63	Browns Island, foot	9,000
65	Wills Creek	25,000
68	Wells	3,000
70	Mingo Island	6,000
71	Cross Creek	7,000
72.5	Cox	6,000
81	Short Creek *	15,000
83	Pike Island	7,000
85	Twin Island	45,000
89	Upper Wheeling	25,000
91	Wheeling Creek	8,000
94.5	McMahon	14,000
100.5	Little Grave	7,000
102	Big Grave	5,000
108	Captina Island	18,000
113	Fish Creek Island	10,000
115	Kleins	7,000
118	Sunfish	1,000
120	Opossum	22,000
123	Haines	9,000
129	Fishing Creek	15,000
133.5	Williamsons Island, head	6,000
134	Barnes Run *	7,000
135.5	Witten Tow-head	25,000
139	Wells Island	15,000
141	Mill Creek *	11,000
143	Grandview Island	16,000
144	Collins Ripple	3,000
147	Petticoat	4,000
151	Reas Run *	5,000
151	Grape Island, head	16,000
152	Grape Island, foot	8,000
153	Middle Island	4,000
158	Brothers Island *	20,000
167	Carpenters	12,000
169	Marietta Island, head	8,000
171	Muskingum River	2,000
174	Muskingum Island	9,000
175.5	Repparts	15,000
180.3	Cole Island	10,000
185.4	Blennerhassett Island, head	11,000
186.7	James Ripple	7,000
189.4	Blennerhassett Island, foot	8,000
193.3	Newberry Island	18,000
194.5	Mustapha Island, head *	12,000
196.6	Mustapha Island, foot *	4,000
203.3	Belleville Island, foot	11,000
215.7	Buffington Island, head	2,000
216.2	Buffington Island, middle	8,000
220	Sand Creek *	16,000
225	Old Town Tow-head	13,000
233.5	Letart Island, head	20,000
234.4	Letart Island, middle	2,000
235.2	Letart Island, foot (rock)	10,000
268.2	Gallipolis Island, foot	2,000
283.4	Straight	3,000
335	Greenup	6,000
366	Connoconeque	10,000
372.4	Twin Creek *	8,000
	Total	992,000

Of the above, those marked with a star, namely, Duffs, Little Sewickley, Short Creek, Barnes Run, Mill Creek, Reas Run, Brothers Island, Mustapha Island, Sand Creek, and Twin Creek, amounting to about $115,000 worth of work in all, are specially troublesome to coal tows, and either the entire work above estimated or at least the removal of the projecting points of these bars should be done as soon as possible.

SNAGGING.

The $50,000 annually provided by the appropriation for operating snag boats on the Ohio River being sufficient to cover all cost of removing obstructions, the supplemental allotment of $35,000 for snagging contained in the act of March 3, 1899, has not been specially needed so far for that purpose. The project of March 20, 1899, for the expenditure of this sum was, therefore, so modified by authority of the Chief of Engineers under date of December 17, 1900, as to allow the use of $10,000 of this fund in continuing the survey of the Ohio River from Marietta to mouth of Big Miami (which see below).

HARBOR LINES, DUMPAGE, ETC.

Work was continued in the investigation of permits requested, reported violations of law by structures, dumpage, etc., and in the issue of maps and other necessary information.

The steady increase in the number of permits requested, due mainly to the expansion of business by companies using or constructing pipe lines and similar structures, has added largely to the work of investigation and supervision. Owing to the general information already given along the entire river by means of maps, circulars, etc., complaints of violations and requests for information have also been more frequent.

In view of the many mills and factories on the banks of the river in the vicinity of Wheeling and Bellaire, a harbor-line inspector was appointed to specially observe and report on this section; and the master of the United States snag boat performs similar duty over the entire river while the boat is traveling over the river on its regular snagging duties.

A list[1] of permits during the year, showing also those completed, is given below.

The work done in maintaining harbor lines and preventing illegal dumpage is considered of great utility.

ILLEGAL STRUCTURES.

Subsequent to completion of work by Fort Pitt Natural Gas Company, under War Department permit dated December 22, 1899, for placing a gas-pipe line across the Ohio River near Glenfield, Pa., it was found that the pipe was above the bed of the river for the entire width of the channel at one of its shoalest parts. Favorable conditions for complying with the requests of this office to place the pipe as required were neglected, and as complaints were made of the structure and the hull of one steamboat damaged in December, the matter was reported in January, 1901, to the United States attorney for the western district of Pennsylvania for prosecution. This dangerous obstruction was left unremoved by the owners for over six months, with great danger to coal-tow navigation. Further United States legislation appears much needed to allow of more prompt action by the United States Engineer Department in such cases.

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[1] Not printed.

SPECIAL IMPROVEMENTS.

ICE PIERS.

Special projects are in existence, as follows, for special work authorized in the act of March 3, 1899, or in previous acts:

Ashland, Ky., 320 miles below Pittsburg (and repairs at Pomeroy, 248.5 miles; Middleport, 249.5 miles; Gallipolis, 267.5 miles, and Ironton, Ohio, 325 miles).—Ice piers, one each at Pomeroy, Middleport, Gallipolis, and Ironton, Ohio, and at or near Ashland, Ky., were ordered by the river and harbor act of August 5, 1886, at a total cost of $37,500, to be taken from the Ohio River general improvement fund, the work to be in accordance with the plans of the Chief of Engineers. A project submitted April 25, 1887 (E. D. 1802-'87), deeds of relinquishment, approved July 13, 1888 (E. D. 1981-B. '88), and contracts approved by the Chief of Engineers October 17, 1888 (E. D. 2806, 2783, 2854-C. 1888), provided for the construction of the piers at Pomeroy, Middleport, Gallipolis, and Ironton, and all these piers were completed in 1889. By the same project the construction of the Ashland pier was postponed indefinitely, because it was found impossible to secure the relinquishment of riparian rights required by law. Balance available July 1, 1901, and held for work of construction of Ashland pier and for repairs of all piers already built, if done in accordance with plans of the Chief of Engineers, $11,401.79.

Pomeroy, Ohio, 247 miles below Pittsburg (and repairs at Middleport, Ohio, 249.5 miles, and Hartford, W. Va., 244 miles).—The construction of an additional (second) ice pier at Middleport, Ohio, pursuant to plans of the Chief of Engineers, and of one at either Syracuse, Ohio, or Hartford, W. Va., upon plans like those of prior built piers, and the improvement of the ice pier already existing at Pomeroy, Ohio, was ordered by the river and harbor act of August 17, 1894, at a total cost of $18,750, or so much as may be necessary, to be taken from the Ohio River general improvement fund. A project submitted March 3, 1896, approved by the Secretary of War March 14, 1896 (E. D. 14417), provided for the piers at Middleport and Hartford, the latter place being selected as preferable to Syracuse; and a third crib added to the old ice pier at Middleport, and a new ice pier of two cribs at Hartford were completed in 1896. The same project postponed indefinitely the improvement of the Pomeroy ice pier. Balance available July 1, 1901, and held for work of construction of the Pomeroy pier and for repair of all piers already built, $10,515.58.

Syracuse, Ohio, 243.5 miles below Pittsburg (and at Middleport, Ohio, 249.5 miles, and at the mouth of Big Hocking River, 197 miles).—The construction of an ice pier at Syracuse, Ohio, of an additional ice pier (third crib) at Middleport, Ohio, and of one ice pier at or near the mouth of the Big Hocking River, at a total cost of $22,250, if necessary, to be taken from the Ohio River general improvement fund, was allowed by the river and harbor act of June 3, 1896, the work to be at the discretion of the Secretary of War. Projects submitted February 18, 1897, provided for building one ice pier at Syracuse and another on the West Virginia side of the Ohio River opposite Hockingport, Ohio, at an estimated cost of $7,000 for each pier (two cribs each), work at Middleport being omitted in view of that done in 1896 under 1894 appropriation. All work on these piers has been postponed indefinitely, by direction of the Secretary of War, for reasons as given in indorsement of March 12, 1897 (E. D. 19741). Balance available July 1, 1901, for work at Syracuse and Hockingport and for repairs of the existing pier at Middleport, at the discretion of the Secretary of War, $22,127.41.

Examination of all existing ice piers has been made during the year, and reports, recommendations, and estimates of cost of further work submitted by Assistant Engineer R. R. Jones, whose report is appended. The ice piers at Kerrs Run, Middleport, and Gallipolis, which have been of service to navigation, are decaying and need renewal; those at Hartford City, Pomeroy, Ironton, Portsmouth, and Ripley, have outlived their usefulness, are considered to be not worth either repair or renewal, and should soon be removed; and piers at Big Hocking, Greenup, and Maysville appear desirable. The balance of existing funds will be held for renewals at Middleport and Gallipolis and construction at Big Hocking.

The timbers of the two outer cribs of the ice pier at Portsmouth having decayed, the cribs had fallen to pieces and become an obstruction to navigation. At the general request of the authorities of the city and of steamboatmen for their removal, the Chief of Engineers granted authority for the temporary removal of the dangerously obstructing portions. This work was in progress at the end of the year by the U. S. snag boat *E. A. Woodruff.*

Harbor of refuge at Maysville, Ky.—The report on the preliminary examination of this locality was published as House Doc. No. 148, Fifty-sixth Congress, second session. The survey subsequently ordered was reported upon under date of May 20, 1901, with recommendation for the construction of the pier contemplated at an estimated cost of $21,000. No funds are at present available for this work, the appropriation clause of the act having passed the House of Representatives only.

EMBANKMENT, BANK PROTECTION, AND DIKES.

Lawrenceburg, Ind., 489 miles below Pittsburg.—Work under contract with John W. Scott for repair of this embankment, which was nearly finished at the close of the last fiscal year, was continued until July 10, 1900, and the furnishing and sowing of grass seed was then done during March of the present year, by which all work was finally completed.

Shawneetown, Ill., 848 miles below Pittsburg.—Repair of embankment under authorized agreement with C. H. Glandorf, in progress at the beginning of the year, was continued until December 17, 1900, and the sowing of grass seed was done in March, 1901, by which this work was practically completed.

Evansville, Ind., 783 miles below Pittsburg.—Prevention of cut-off. A contract was entered into June 19, 1900, with Charles McNutt and Sanders C. Hornbrook for about $1,200 worth of work in repairing damage to this bank protection, but owing to the unfavorable stage of river in July nothing was done, work being practicable only during the lower stages of water. Toward the end of August the contractors completed all pile driving. The placing of brush, slabs, and stone along the piling at foot of bank was carried on until September 28, when the entire work was completed.

Improvement of harbor.—A contract was entered into June 19, 1900, with Charles McNutt and Sanders C. Hornbrook for about $3,500 worth of work in extending the dikes previously built and strengthening the shore ends. Work was begun July 13, and all grading finished during the month. The delivery and placing of stone was continued until August 11, when the entire work was completed.

Mound City, Ill., 959 miles below Pittsburg.—Under subproject of March 20, 1899, for the expenditure of $25,000 for dikes and dredging at this point, the Chief of Engineers on May 5, 1900, approved the plans and location for the construction of one new dike and repair of one old dike, pursuant to which proposals were opened June 29, 1900.

Award was authorized July 20, 1900, to James Short, of St. Charles, Mo., at an aggregate cost of $18,935. About 1,000 cubic yards large stone was delivered in October for repair of old dike, but the stage of river was then too high to permit placing it and remained so throughout the month, and as there was no probability of a suitable stage for work, further operations were postponed until the low-water season of 1901.

DREDGING AND EXCAVATION.

Madison, Ind., 553 miles below Pittsburg.—Under the project approved April 10, 1899, for expenditure of $20,000 appropriated by the river and harbor act of March 3, 1899, for dredging in this harbor, the William A. Kirk plant began operations July 18 and continued until November 17 on the dredging of the bar below the public wharf, the object being to deepen the channel in such manner as to cause scour along the front of the city landing. The entire area dredged covers an average length of 970 feet and extreme width of about 510 feet to a depth of 6 feet below low water, with the exception of about 30 by 200 feet, 5 feet below low water, dredged while the river was too high to reach grade. During high water in August an area 30 by 550 feet, 5 feet below low water, was dredged along the city front just above the upper end of the city wharf. This work was continued from November 17 to 24 for a farther distance of 500 feet, with a depth of 6 feet below low water, and widened to about 60 feet for 320 feet in the middle portion.

Location of dredging, dumpage, etc., is shown on progress map appended to assistant's report.

On suspension of work, November 24, dredging in Madison Harbor was practically completed, so far as allowed under the special appropriation of 1899.

Evansville, Ind., 783 miles below Pittsburg.—Under the project approved April 10, 1899, for expenditure of $20,000 diverted by the river and harbor act of March 3, 1899, from the unexpended balance of the appropriation of June 3, 1896, for dredging along the city front at Evansville, the H. S. Brown plant began work July 19 and continued until September 25 in the channel along the public wharf. The total area dredged, 6 feet below low water, averages about 160 wide by 1,200 feet long.

Location of dredging, dumpage, etc., is shown on progress map appended to assistant's report.

The plant was then withdrawn for special service on dredging bars between Louisville and Evansville, as mentioned above.

Brooklyn, Ill., 923 miles below Pittsburg.—Owing to the stoppage of work at Mound City by high water, the United States dredges were sent to Brooklyn, where they commenced operations on October 12, under the project approved April 4, 1899, for expenditure of $10,000 on this work.

As the dredging at this place in 1898 and 1899, at the lower end of the landing, was done at a high stage of river, some ridges were unavoidably left between cuts, and a number of rocks too large to enter the dredge dipper were pushed aside and left. This area was dredged over, the rocks removed to a little more than 6 feet below low water, the landing and its approaches cleared of rocks, etc., and the harbor extended downstream by dredging off the cemented gravel bar along the shore. At the upper end of the landing a deposit of mud, gravel, and logs was cleared away from the area which had been dredged in 1897 and 1898. A rapid rise of the river prevented work after November 23, with no prospect of resumption, and operations were accordingly suspended for the season.

The area dredged on the cemented gravel bar at the lower end of the landing has an average of about 600 feet length by 230 feet width; at the wharf two cuts were made, covering an area 900 feet by 40 feet; above the landing the area dredged was 340 feet long and 175 feet wide, all dredging being 6 feet below low water.

Location of dredging, dumpage, etc., is shown on progress map appended to assistant's report.

Mound City, Ill., 959 miles below Pittsburg.—The projects of April 28, 1893, May 11, 1897, and March 20, 1899, provided for opening a new channel from the middle of the river opposite Mound City towhead to the Illinois shore at Mound City wharf, a distance of about 6,000 feet, with a width of 300 feet, and a least channel depth of 6 feet below low water. Work under the approved project for dredging and diking at this place was resumed by the U. S. dredge *Ohio* on August 21, on left of the center line of the new channel, and above the cemented gravel lump, opposite the tow-head, in position to insure removal of all hard material as the work progressed downstream, the object being to direct the current through the new channel and prevent the low-water channel from cutting through on the old line toward the Kentucky shore. The cut made, assisted by excavated material dumped across the upper end of the old channel, has so far proved effective, the river current through it having increased in strength in a manner to indicate that this season's low-water channel will be established on the new line.

On October 6 the work was stopped by a rise in the Mississippi River, which backed into the Ohio, making a depth too great for dredging.

The area dredged increased the width of the new channel 75 feet for a distance of 1,400 feet, with a depth of 6 feet, except a section of cemented gravel, 200 by 35 feet, which was too hard to dredge, and was scraped off to a depth of 2 to 4 feet below low water, preparatory to blasting.

Location of dredging, dumpage, etc., is shown on progress map appended to assistant's report.

During September a survey was made of that part of the river which includes the dikes being constructed under this project (see Embankment, above) and the most difficult portion of the new channel.

An estimate in detail of the amount and cost of dredging required at Mound City is given in the report of Mr. E. J. Carpenter, hereto appended.

SURVEYS.

Marietta to mouth of Big Miami River, 171 to 487 miles below Pittsburg.—The United States quarter boat No. 1 and steamer *Edna* were taken from winter quarters to Greenup, Ky., 333 miles below Pittsburg, and the base-line, precise-level, bench-mark, and water-slope parties commenced work on July 25. At the end of September the various parties had completed work to Nine-mile Bar, 452 miles below Pittsburg. The stretch from Nine-mile to Petersburg having been covered by these parties during the season of 1899, the work on the entire Ohio River from Pittsburg, Pa., to Petersburg, Ky., a distance of about 493.3 miles, has been completed so far as this character of work is concerned. After reaching Nine-mile Bar the survey parties were rearranged, with a view to completion of soundings and topography in the vicinity of Cincinnati. Mile points and metallic bench marks were also set with regard to mileage from Pittsburg, Pa.

Quarter boat No. 2 was towed up to Spencer's landing, 178 miles below Pittsburg, and work was begun July 17 at that point by the second section, embracing sounding and topographical parties. On October 22 the party had reached a point 360 miles below Pittsburg and was then transferred to a point about 2 miles below Cincinnati in order to insure completion, during the present season, of all work between Nine-mile Bar and Petersburg, Ky., 452 to 493 miles below Pittsburg. The field work on this section was finished on November 7 and both working parties and their quarter boats were then towed up the river to resume work on unfinished portions of the survey, which was continued until November 24, when temporarily suspended by excessively bad weather. Between November 24 and 30 the river reached a high stage (nearly 40 feet at Cincinnati), and work was confined to topography on the higher banks and towns, and to running auxiliary lines from which topography was taken. This work was continued until December 10, when operations in the field were entirely suspended and the boats sent to winter quarters in the Kentucky River. The survey work of the season on base lines, precise levels, water slopes, and bench marks covered about 121 miles; soundings and topography were completed over about 192 miles, leaving 55 miles of such work yet to be completed.

After the suspension of field work the platting of the maps of the survey so far as made was continued until April, when completed; work on tracing of these maps was in progress at the end of the year.

A progress map of the survey is herewith.

Additional funds being required for continuation of work on this survey, the Chief of Engineers, by indorsement dated December 17, 1900, authorized the use of $10,000 for this purpose out of the provisional allotment for snagging contained in the act of March 3, 1899.

At the close of the year preparations were in progress for resuming field work as soon as conditions are favorable.

Dams first needed, and estimates of cost.—The surveys have now progressed far enough to show the number and approximate location of all dams from Marietta to below the Big Miami. The estimates of the preliminary report of April 17, 1900, on this survey (page 3207, annual report 1900), gave the total cost at $19,950,000 for 21 dams, with an average lift of about 6.9 feet and an average cost of $950,000 per dam. The survey, as mapped, shows that 20 dams, with an average lift of 7.2 feet, can be so placed as to give the desired results to better advantage. Dam 18, located under prior surveys, is already provided for. The upper dam of the present series will then be Dam No. 19, below Parkersburg, and the lower dam will be Dam No. 38, below the Big Miami River. The additional average lift will make the individual dams a little more expensive without adding to the total estimate. For the 5 dams recommended for early construction in the original examination and survey report the surveys show good locations, as follows:

No. of dam.	Location by town and river.	Approximate distance below Pittsburg.
		Miles.
19	Below Parkersburg, W. Va., and Little Kanawha River	190.1
26	Below Great Kanawha River and Gallipolis, Ohio	274
29	Below Big Sandy River and Ashland, Ky	320.1
31	Below Portsmouth, Ohio, and Scioto River	358.4
37	Below Cincinnati, Ohio, and Cullums Ripple	481.3

Dams Nos. 19, 26, 29, and 31 are now estimated to cost the $950,000 each which was originally given as the average of the original series of 21 dams (p. 3207, annual report 1900). Dam No. 37 is now estimated to cost the $1,050,000 of its own special estimate (p. 2367, annual report 1899, and p. 3209, annual report 1900). Any appropriations for these 5 dams should be based upon the above-named estimates of $950,000 each for Dams Nos. 19, 26, 29, and 31, and $1,050,000 for Dam No. 37. The above locations and estimates will allow of the 15 other dams of the series, from Nos. 19 to 38, inclusive, being placed advantageously, and of the entire series being constructed within the $19,950,000 of the original estimates; but the exact locations and individual estimates of cost of the 15 dams to be last built must await the completion of the survey work of the summer of 1901.

SUPERINTENDENCE.

The works carried on during the year have been under the special direction of assistants, as follows: Survey of Ohio River from Marietta to mouth of Big Miami; embankments at Lawrenceburg, Ind., and Shawneetown, Ill.; dike at Caseyville, Ky.; removal of Licking bar, and examination of ice piers, under Mr. R. R. Jones, assistant engineer; operation of United States dredges and hired dredging plants and dikes at Mound City, under Mr. E. J. Carpenter, assistant engineer; examination and reports on dams and dikes and Ohio River bridges and local surveys, under Messrs. A. L. Lucas and William M. Hall, assistant engineers; dikes and bank protection at Evansville, Ind., under Mr. W. A. Christian, assistant engineer. The above assistants have attended to such work with great care and efficiency. Their reports in detail are hereto appended.

DETERIORATION OF PAST WORKS OF IMPROVEMENT.

The improvements of the Ohio River have consisted mainly of movable dams, permanent low dams and dikes, dredging, bank protection, and ice piers. Many of them need repair, as given below in detail, but none of them are at present unworthy of further improvement.

Certain of the low dams and dikes on the river have gradually been damaged by annually repeated floods and ice floes. These dikes and dams have been examined by the assistant engineers from time to time when low water permitted, the last complete careful examination being, however, several years ago. The last estimates are as follows:

Designation.	Estimated cost of repairs.
The upper 26 miles, between Pittsburg and Dam No. 6—that is, down to the lowest movable dam under construction; 3 dams and 1 dike	$28,300
The next 145 miles, between Dam No. 6 and Dam No. 18 at Marietta (the lowest movable dam for which funds have been provided); 14 dams and 11 dikes	216,817
The next 318 miles, between Marietta and the Ohio-Indiana State line (the lowest point for which surveys for movable dams have been authorized); 10 dams and 20 dikes	124,780
The next 109 miles, between the Ohio-Indiana State line and Louisville (the Falls of the Ohio); 13 dikes	34,800
The next 367 miles, between Louisville and Cairo (the mouth of the Ohio); 3 dams and 41 dikes	161,000
Total	565,697

The original cost of these dams and dikes was many times the now estimated cost of their repair. As a rule they have stood well, have done excellent and permanent work, and their cost will have been money well spent, even if they are never repaired. As fast as movable dams are built the low permanent dams and dikes, although becoming of lesser importance, will still be necessary to control the channel at or about the stage at which the movable dams are raised or lowered—that is, at which open navigation ends or begins—and their improvement will generally consist of lowering or removing the channel ends and raising or strengthening the shore ends, such work to be gradual and its full extent to be finally determined only after the movable dams are completed and put into regular service. The full repair of all dams from Pittsburg to Cairo is not immediately necessary, but funds should be provided for such work as fast as practicable, leaving the time of actual repair until favorable low-water seasons, when it can be done to best advantage. The original project has always been considered as including necessary minor repairs, but not extensive restorations unless specially described in advance in annual reports or where provided for by special allotments.

Certain dredged channels in the river have been gradually filling with moving sand and drift and need a partial redredging. The last estimates for this work are as follows:

Designation.	Estimated cost of repairs.
Phillis Island	$1,000
Head of Line Island	1,500
Wheeling Creek Bar	3,750
Foot of Gallipolis Island	3,000
Quicks Run Bar	1,500
Brush Creek Bar	3,000
Dredging repair total	13,750

The dredged channels have stood remarkably well. The worst places now left in the river are those which have as yet not been dredged at all. The original project has always been considered as including minor redredging of channels, but not extensive work or new work except where specially described in advance in annual reports or where provided for by special allotments.

The bank-protection work and ice piers, where built, have stood well, and no special appropriations for repairs are considered necessary at the present time.

The grand total of cost of repairs not otherwise specially provided for is therefore at present:

Low dams and dikes	$565,697
Dredged channels	13,750
Grand total	579,447

STAGES OF THE OHIO RIVER DURING 1900.

The following are the records of the gauges at Pittsburg, Cincinnati, and Evansville, which may be taken to represent the navigable condition of the upper, middle, and lower Ohio:

Gauge of Davis Island Dam, near Pittsburg, Pa.

[When the dam is up, low-water readings must be obtained from the gauge at the lower end of the lock. On this gauge 3 feet 2 inches corresponds to a navigable depth of 3 feet, and 6 feet corresponds to the same depth in the river.]

Month.	Depth in channel.			Gauge readings.	
	Under 3 feet.	3 feet and over.	6 feet and over.	Highest.	Lowest.
1900.	*Days.*	*Days.*	*Days.*	*Feet.*	*Feet.*
January	0	31	20	16.9	3.6
February	0	28	22	16.2	4.1
March	0	31	31	14.5	8
April	0	30	29	9.2	5.7
May	0	31	0	5.3	3.4
June	0	30	3	8.4	3.1
July	0	31	4	6.5	3.1
August	17	14	0	5.5	1.6
September	29	1	0	3	1.1
October	28	3	0	3.6	1.2
November	12	18	9	25.6	2.2
December	0	31	14	13.6	4.1
Total	86	279	132	....	....

Cincinnati gauge.

[The zero of this gauge is about 2 feet below low water; readings of about 4 feet correspond to about 3 feet in the channel, and those of 7 feet to about 6 feet in the channel.]

Month.	Depth in channel.			Gauge readings.	
	Under 3 feet.	3 feet and over.	6 feet and over.	Highest.	Lowest.
1900.	*Days.*	*Days.*	*Days.*	*Feet.*	*Feet.*
January	0	31	31	31.8	7.3
February	0	28	28	37.3	11.2
March	0	31	31	36.8	19.4
April	0	30	30	22.7	13.9
May	0	31	31	16	9.1
June	0	30	30	16.8	8.4
July	0	31	31	13.3	7.4
August	0	31	24	14.3	4.9
September	0	30	6	7.7	3.5
October	0	31	4	11.4	3.1
November	0	30	15	39	4.7
December	0	31	31	40	7.8
Total	0	365	292	....	....

Evansville gauge.

[The zero of this gauge is about at low-water line; readings of 2 feet correspond to about 3 feet in the channel, and readings of 6 feet correspond to about 6 feet in the channel.]

Month.	Depth in channel.			Gauge readings.	
	Under 3 feet.	3 feet and over.	6 feet and over.	Highest.	Lowest.
1900.	*Days.*	*Days.*	*Days.*	*Feet.*	*Feet.*
January *a*	0	15	15	26	13.3
February	0	28	28	31.1	10
March	0	31	31	29.7	17.4
April	0	30	30	21.4	12.6
May	0	31	31	14.3	6.5
June	0	30	30	14	8.7
July	0	31	26	10.3	5.4
August	0	31	12	11.4	4
September	16	14	0	5.9	1.5
October	28	3	0	3.6	1
November	8	22	8	28.3	2
December	0	31	31	33.6	6.9
Total	52	297	242	....	....

a From January 1 to 16 it was impossible to get gauge readings on account of ice and a barge lying on gauge.

OPERATION OF DRAWS IN HIGH BRIDGES.

There are no low drawbridges on the Ohio River. The general Ohio River bridge law requires that all bridges shall have a height of at least 40 feet above high water, and, since large steamboats require more than 40 feet, it is also provided that all bridges below the Cincinnati Suspension Bridge shall have a draw for use in high water unless they give a clearance of at least 53 feet above high water. There are three high-water draws on the Ohio River, but the draw in the Ohio Falls Bridge at Louisville is exceptionally located and no record of its operation is kept. Reports received from the Cincinnati Southern Railroad Bridge at Cincinnati and the Kentucky and Indiana Bridge at Louisville state that the draws were not opened for the passage of boats during the calendar year ending December 31, 1900.

STOPPAGE OF NAVIGATION.

The usual period of low water prevailed from August 2 to November 22 for Pittsburg traffic, and from August 15 to November 22 for Louisville traffic.

Through navigation to Pittsburg was temporarily suspended from February 12 to March 5 by ice.

Navigation was temporarily suspended from April 25 to 30 by high water.

Losses by collision with bridges.

The following table shows the reported losses sustained by the commerce of the Ohio River by collision with the piers of bridges crossing the Ohio River to the end of the calendar year 1900.

Date, etc.	Owner.	Steamboat.	Loss.	Amount.
Ohio Falls Bridge:				
Previously reported	....	....	....	$185,350.00
December 4, 1900	The Monongahela River Consolidated Coal and Coke Co.	Harry Brown	1 empty coal boat.	500.00
December 5, 1900	.....do	Iron Age	1 barge coal	2,200.00
Total				188,050.00

Date, etc.	Owner.	Steamboat.	Loss.	Amount.
Kentucky and Indiana Bridge:				
Previously reported				$27,767.00
December 4, 1900	The Monongahela River Consolidated Coal and Coke Co.	Pacific No. 2	2 barges coal	6,500.00
Total				34,267.00

Losses by collision with Ohio River bridges to December 31, 1900.

Beaver Bridge	$61,840.00
East Liverpool Bridge	1,500.00
Steubenville Bridge	118,858.00
Wheeling and Martins Ferry Bridge	12,150.00
Bellaire Bridge	148,026.00
Parkersburg Bridge	101,848.47
Point Pleasant Bridge	9,600.00
Kenova Bridge	24,900.00
Newport and Cincinnati Bridge	48,107.00
Covington and Cincinnati Bridge	93,300.00
Cincinnati Southern Railroad Bridge	14,812.00
Louisville and Jeffersonville Bridge	7,800.00
Ohio Falls Bridge	188,050.00
Kentucky and Indiana Bridge	34,267.00
Henderson Bridge	22,520.00
Cairo Bridge	32,419.95
Total	919,998.42

SUGGESTED NEW LEGISLATION.

The experience of the past year on the Ohio River appears to indicate the desirability of some legislation to allow of the immediate removal of under-water obstructions other than wrecks, especially when such obstructions are of a particularly dangerous nature (as in the case of gas and oil pipes), and where they exist without any authority of law or in violation of special permits allowable under the law.

The river and harbor act of March 3, 1899, provided for the immediate or early removal of sunken wrecks. Such legislation might be extended to cover other sunken obstructions by the introduction in the next river and harbor bill of a new paragraph somewhat as follows:

> Section —.—That sections fifteen, nineteen, and twenty of the river and harbor act of March third, eighteen hundred and ninety-nine, with reference to sunken wrecks in navigable waters, be herewith so amended as to apply equally to sunken wires, cables, pipes, and all other under-water constructions of any sort, so far as the same may obstruct and endanger navigation, and may have been laid or built without permission from the Secretary of War, or do not comply with such permission.

The necessity of some such legislation as the above has been made evident several times during the past few years in this district. Occasionally the snag boat, while removing wrecks, has pulled up, unintentionally, portions of private property, including even under-water railroad tracks. In such cases the owners have protested against the destruction of their property, and have made claims for reimbursement for such destruction. Very recently a gas-pipe line in the upper Ohio River, authorized by the War Department under the proviso that it be placed and maintained below the surface of the river bed, has been subsequently found to lie across the river channel in such way as to prevent the passage at time of dead low water of all boats that drew more than 6 inches, and to be liable, from its extent, position, and inflammable contents, to wreck and set fire to passing boats as soon as the stage of water was high enough to completely hide the obstruction. This particular obstruction might easily have sunk a passenger boat or towboat or the front end of a coal tow, with great loss to property and perhaps life, and perhaps furthermore completely closing the channel to all navigation for several days. In such cases existing law provides only for the removal of such obstructions by injunction or prosecution through the United States district attorney. If the obstruction were on land in plain sight of everybody it might be allowable to wait for the slow progress of law in such a case; but the obstruction being under water and out of sight such delays are liable to lead to such great dangers to life and property that the law should allow of immediate action to secure the immediate removal of the obstructions and the prevention of such danger.

ESTIMATES.

In work of the character of that for the improvement of the Ohio River it is impossible to determine in advance just where and how much work will be needed for making good navigation upon the entire length of the river, and therefore it is impossible to submit estimates for complete improvement. The work must be progressive and tentative, and, owing to the varied interests and communities along nearly 1,000 miles of river, the locations of works must be at considerable distances apart, so that no one reach of river can be taken in hand and improvement completed in advance of other parts of the river unless large amounts of money are provided. The great and growing commerce of the river, its numerous cities, and the rapid increase of the already large population of the valley should appeal in strong terms for adequate appropriations for such betterment of the navigation as it is certain can be obtained by well-known methods. The sum of $1,000,000 can be profitably used and produce immediate results in great improvement for the movement of the vast commerce of the river. Attention is particularly invited to the commercial statistics appended.

Money statement.

July 1, 1900, balance unexpended		$397,173.23
June 30, 1901, amount expended during fiscal year		159,952.38
July 1, 1901, balance unexpended		237,220.85
July 1, 1901, outstanding liabilities		3,818.22
July 1, 1901, balance available		233,402.63
July 1, 1901, amount covered by uncompleted contracts		23,072.60
Amount (estimated) required for completion of existing project		Indefinite.
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901:		
For works of improvement	$500,000.00	
For maintenance of improvement	200,000.00	
		700,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

Statement of amounts and dates of all appropriations for this work.

Act of Congress.	Appropriation.	Allotment.	Remarks.
March 3, 1827	$30,000.00		
March 3, 1835	50,000.00		
July 2, 1836	20,000.00		
March 3, 1837	60,000.00		
July 7, 1838	50,000.00		
June 11, 1844	100,000.00		
March 3, 1847	6,479.25		
August 30, 1852	90,000.00		
June 23, 1866		$172,000.00	Improving Mississippi, Missouri, Arkansas, and Ohio rivers.
Do		80,000.00	Snag boats and apparatus for improving Western rivers.
March 2, 1867	100,000.00		
July 25, 1868		85,000.00	Repair, preservation, extension, and completion of river and harbor works.
July 11, 1870	50,000.00		
March 3, 1871	50,000.00		
June 10, 1872	200,000.00		
March 3, 1873	200,000.00		
June 23, 1874	150,000.00		
March 3, 1875	300,000.00		
August 14, 1876	175,000.00		
June 18, 1878	300,000.00		
Do	50,000.00		Harbor of refuge at or near Cincinnati.
March 3, 1879	250,000.00		
June 14, 1880	250,000.00		
March 3, 1881	350,000.00		
March 21, 1882	100,000.00		Continuing work on Davis Island dam.
August 2, 1882	350,000.00		
Do	16,000.00		Harbor of refuge near Cincinnati, Ohio.
July 5, 1884	600,000.00		
Do	17,000.00		Do.
August 5, 1886	375,000.00		
August 11, 1888	380,000.00		
September 19, 1890	300,000.00		
January 19, 1891	2,128.87		Relief of Stubbs & Lackey. Treasury settlement No. 2593.
July 13, 1892	360,000.00		
August 18, 1894	250,000.00		
June 3, 1896	250,000.00		
July 1, 1898		15,000.00	For restoring levee and banks of Ohio River at or near Shawneetown, Ill.
March 3, 1899	375,000.00		
Total	6,206,608.12	352,000.00	

LIST OF CONTRACTS IN FORCE DURING THE FISCAL YEAR ENDING JUNE 30, 1901.

Repairing bank protection near Evansville, Ind.—Charles McNutt and Sanders C. Hornbrook, June 19, 1900; approved July 7, 1900; be prepared to commence ten days after receipt of notification of approval of contract; terminate December 31, 1900; completed September 28, 1900.

Dike extension near Evansville, Ind.—Charles McNutt and Sanders C. Hornbrook, June 19, 1900; approved July 7, 1900; be prepared to commence ten days after receipt of notification of approval of contract; terminate December 31, 1900; completed August 11, 1900.

Hire of dredging plant.—William A. Kirk, June 26, 1900; approved July 7, 1900; to commence ten days after receipt of notice; terminate when discharged; supplemental contract for operating plant by separate crews for a total of sixteen or twenty-four hours each working day, August 29, 1900; approved September 13, 1900; plant discharged November 28, 1900.

Hire of dredging plant.—H. S. Brown, June 28, 1900; approved July 10, 1900; to commence ten days after receipt of notice; terminate when discharged; supplemental contract for operating plant by separate crews for a total of sixteen or twenty-four hours each working day, September 19, 1900; approved October 12, 1900; plant discharged November 28, 1900.

Hire of towboat and crew as tender to United States dredges.—J. T. Duffy, July 9, 1900; approved July 18, 1900; commence when ordered; terminate about December 1, 1900; towboat discharged November 27, 1900.

Constructing one steel dredge crane.—New Jersey Foundry and Machine Company, January 19, 1900; approved February 8, 1900; be prepared to commence twenty days after receipt of notification of approval of contract; terminate June 20, 1900; extended to June 30, 1900; extended to August 19, 1900; extended to September 3, 1900; completed August 28, 1900.

Constructing dike below mouth of Tradewater River.—Hampton G. Grainger, July 27, 1900; approved August 7, 1900; be prepared to commence twenty days after receipt of notification of approval of contract; terminate on or before December 31, 1900, if stage of water permits; extended to December 31, 1901.

Constructing dikes in the Ohio River near Mound City, Ill.—James Short, July 30, 1900; approved August 13, 1900; be prepared to commence twenty days after receipt of notification of approval of contract; terminate November 30, 1900, if stage of water permits; extended to November 30, 1901.

Repairing embankment at Lawrenceburg, Ind.—John W. Scott, August 14, 1899; approved September 1, 1899; be prepared to commence twenty days after receipt of notification of approval of contract; terminate February 28, 1900; extended to April 28, 1900; extended to June 28, 1900; extended to July 28, 1900; completed July 10, 1900.

STAGES OF THE OHIO RIVER.

Highest, lowest, and average stages of the Ohio River at Cincinnati each calendar year from 1860 to 1899, inclusive, with the highest stage during the floods of 1832 and 1847.

Calendar year.	Highest stage.			Lowest stage.			Average for the year.	
	Date.	Stage.		Date.	Stage.			
		Ft.	*In.*		*Ft.*	*In.*	*Ft.*	*In.*
1832	Feb. 18	64	3	....	....		....	
1847	Dec. 17	63	7	....	....		....	
1860	Apr. 16	49	2	Oct. 3	5	4	16	0
1861	Apr. 19	49	5	July 13	5	1	19	1
1862	Jan. 24	57	4	Oct. 31	2	4	17	5
1863	Mar. 12	42	9	Oct. 6	2	6	15	0
1864	Dec. 23	45	1	Aug. 6	3	1	16	8
1865	Mar. 7	56	3	Oct. 19	5	8	21	10
1866	Sept. 26	42	6	Aug. 17	4	9	19	2
1867	Mar. 14	55	8	Oct. 19	3	0	17	0
1868	Mar. 30	48	3	July 21	5	1	18	8
1869	Apr. 2	48	9	Aug. 21	5	4	19	8
1870	Jan. 19	55	3	Oct. 4	3	10	17	10
1871	May 13	40	6	Oct. 12	2	8	11	10
1872	Apr. 13	41	9	Oct. 14	3	0	11	8
1873	Dec. 18	44	5	Oct. 12	3	8	18	5
1874	Jan. 11	47	11	Sept. 22	2	4	15	8
1875	Aug. 6	55	4	Sept. 19	4	3	18	9
1876	Jan. 29	51	9	Sept. 4	6	2	18	2
1877	Jan. 20	53	9	Oct. 9	3	3	15	0
1878	Dec. 15	41	4	Oct. 24	4	4	16	9
1879	Dec. 27	42	9	Oct. 23	2	6	14	6
1880	Feb. 17	53	2	Oct. 28	3	9	17	0
1881	Feb. 16	50	7	Sept. 18	1	11	16	11
1882	Feb. 21	58	7	Nov. 1	6	1	*a*22	1½
1883	Feb. 15	*b*66	4	Sept. 21	3	7	*a*19	5½
1884	Feb. 14	*c*71	0¾	....do....	2	9	*a*17	4
1885	Jan. 20	46	0	Sept. 26	2	6	*a*15	7
1886	Apr. 9	55	9	Nov. 1	3	4	*a*17	10
1887	Feb. 5	56	3	Sept. 23	2	8	*a*15	1½
1888	Apr. 1	39	11	Aug. 7	5	3	*a*17	11
1889	Feb. 22	38	8	Sept. 13	5	3	*a*18	6
1890	Mar. 26	59	2	Aug. 30	5	9	*a*25	8
1891	Feb. 25	57	4	Oct. 7	4	5	*a*20	6
1892	Apr. 25	43	8	Nov. 5	3	5	*a*16	6
1893	Feb. 20	54	11	Aug. 30	3	7	*a*17	8
1894	Feb. 15	35	6	Sept. 14	3	1	*a*12	9
1895	Jan. 14	48	4	Oct. 28	2	3	*a*12	2
1896	Apr. 4	47	8.4	Sept. 25	5	6	*a*17	1.2
1897	Feb. 26	61	2	Oct. 18	3	1	*a*16	5
1898	Mar. 29	61	5	Oct. 6	4	6	*a*19	8
1899	Mar. 8	57	2.4	Nov. 2	3	4.8	16	8.6
1900	Dec. 1	40	0	Oct. 21	3	2	13	8

a Prepared from the stages as shown by the waterworks marks daily at 6 a. m. and 6 p. m., the previous years having been made from one daily observation at 6 a. m.

b Four o'clock to 5 o'clock a. m., inclusive.

c Twelve o'clock noon to 1.30 p. m.

MONTHLY COMPARISONS OF RIVER AND RAINFALL.

Highest, lowest, and average monthly stages of the Ohio River, and the monthly and annual rainfall at Cincinnati in two years ending December 31, 1899 and 1900.

Months.	Highest.				Lowest.				Average.		Rainfall.	
	1900.		1899.		1900.		1899.		1900.	1899.	1900.	1899.
	Date.	Feet.	Date.	Feet.	Date.	Feet.	Date.	Feet.	Feet.	Feet.	Inches.	Inches.
January	23-24	31.8	16	41.8	10-11	7.3	4	19.0	18.8	23.7	2.54	3.32
February	17	37.3	27	39.0	7	11.2	18	11.5	22.7	26.1	2.22	2.04
March	7	36.8	8	57.4	20	19.4	18	24.2	29.1	38.4	1.75	5.94
April	2	22.7	1	51.6	21	13.9	29	14.4	18.0	35.7	1.43	1.21
May	1	16.0	13	23.5	18-20	9.3	30	12.5	11.2	17.7	3.94	4.83
June	21	16.8	5	18.7	16-18	8.4	13-28	11.0	10.8	14.5	1.01	3.27
July	31	13.8	1	11.0	12	7.4	14-15	6.5	9.5	8.8	3.48	1.58
August	3	14.3	11	13.5	15-16	4.9	30-31	4.0	8.0	7.9	4.17	3.65
September	1	7.7	20	7.0	19-20	3.5	2- 3	3.8	4.9	5.4	.28	2.18
October	29	11.4	17	4.4	20-22	3.2	25-29	3.5	4.2	3.9	1.45	1.64
November	30	39.0	10	9.3	17-18	4.7	2	3.4	9.1	6.5	4.50	2.60
December	1	40.0	26	23.0	26	7.8	9	6.3	19.2	16.8	1.01	2.98
For the year.	*a*1	40.0	*b*8	57.4	*c*20-22	3.2	*d*2	3.4	13.8	17.1	27.78	34.69

a December. *b* March. *c* October. *d* November.

Depths on bars, Ohio River, at low water of 1900, as reported by packet lines.

[Compiled in office of Maj. Wm. H. Bixby, Corps of Engineers, U. S. Engineer Office, Cincinnati, Ohio.]

PITTSBURG TO DAM No. 6, MERRILL, PA. (28.8 MILES BELOW PITTSBURG).

[Davis Island gauge, 1.4 feet = 0.7 foot (8 inches) above low water (1895). Dam No. 6 gauge, 1.6 feet = 1 foot (12 inches) above low water (1895).]

		Inches.
Oct. 7.	Horsetail Ripple	8
	Lowrie Ripple	9
	Duff Bar	6
	Merriman Bar	9
	Lock No. 3	9
	Deadmans Island	10
Oct. 8.	Logstown Bar	10
	Dam No. 4 (Logstown)	10
	Knox Bar	12
	Wallers Ripple	6
	Lacock Bar	10
	Beaver Shoals	10

DAM No. 6, MERRILL, PA., TO STEUBENVILLE, OHIO (67.6 MILES BELOW PITTSBURG).

[Dam No. 6 gauge, 1.6 feet = 1 foot (12 inches) above low water (1895). Steubenville gauge, 0.75 foot = 0.25 foot (3 inches) above low water (1895).]

		Inches.
Oct. 9.	Raccoon Shoals	10
	Montgomery Island	12
	Phyllis Island	12
	Georgetown Island	12
	Line Island	12
	Babbs Island	12
	Koontz Bar	12
	Baker Island, head	10
	Yellow Creek Bar	14
	Cluster Islands	12
	Blacks Island	14
	Browns Island, head	12
	Browns Island Dam	12
	Browns Island, foot	12
	Wells Bar	12

STEUBENVILLE, OHIO, TO WHEELING, W. VA. (90.1 MILES BELOW PITTSBURG).

[Steubenville gauge, 0.75 foot = 0.25 feet (3 inches) above low water (1895). Wheeling gauge, 0.6 foot = 0.3 foot (4 inches) above low water (1893).]

		Inches.
Oct. 10.	Wells Ripple	12
	Mingo Island	12
	Cox Ripple	12
	Beach Bottom Bar	12
	Short Creek Bar	12
	Sisters Islands	10
	Burlington Bar	12
	Wheeling	10

WHEELING, W. VA., TO MARIETTA, OHIO (171.4 MILES BELOW PITTSBURG).

[Wheeling gauge, 0.6 foot = 0.25 foot (3 inches) above low water (1893). Marietta gauge, 1.9 feet = 0.6 foot (7 inches) above low water (1895).]

		Inches.
Oct. 10.	Wheeling Creek	12
	Boggs Island	12
	McMahons Bar	12
Oct. 11.	Little Grave Creek Bar	14
	Big Grave Creek Bar	14
	Captina Island	12
	Fish Creek Island	12
	Kleins Island	14
	Sunfish Creek Bar	14
	Opossum Bar	12
	McEldowney Bar	14
Oct. 12.	Fishing Creek Bar	12
	Paden Island	20
	Williamson Island	14
	Wells Island	12
	Millcreek Island	14
	Grandview Island	14
	Collins Ripple	12
	Petticoat Ripple	12
	Grape and Bat Island	14
	Rowlands Race	12
	Bull Creek Bar	15
	Carpenter Bar	12
	Duck Creek Bar	14

MARIETTA, OHIO, TO POINT PLEASANT, W. VA. (264.5 MILES BELOW PITTSBURG)

[Marietta gauge, 2 feet = 0.7 foot (8 inches) above low water (1895). Point Pleasant gauge, 1.2 feet = 0.5 foot (6 inches) above low water (1895).]

		Inches.
Oct. 13.	Repperts Bar	18
	James (Vienna) Island	18
	Neal (Coles) Island	18
	Ames Ripple	18
	Blennerhassett Island, foot	18
	Little Hocking Bar	20
	Newberry Island	20
	Mustapha Island	20
	Lea Creek Bar	20
	Belleville Island	20
	De Witts Bar	20
Oct. 14.	Buffington Island	20
	Sand Creek Bar	15
	Old Town towhead	20
	Gosling Bar	24
	Goose Island	20
	Letart Island	22
	Weaver shoals	20
	Wolf Bar	20
	Siegrist Ripple	20
	Eight Mile Island	20

POINT PLEASANT, W. VA., TO HUNTINGTON, W. VA. (307.6 MILES BELOW PITTSBURG).

[Point Pleasant gauge, 1.2 feet = 0.5 foot (6 inches) above low water (1895). Huntington gauge, 3 feet = 1.1 feet (13 inches) above low water (1895).]

		Inches.
Oct. 15.	Kanawha Bar	24
	Gallipolis Island	24
	Clarion Ripple	24
	Racoon Island	20
	Straight Ripple	24
	Little Guyan River	24
	Green Bottom Bar	20
	Dogham Bar	30
	Guyandotte Bar	24

HUNTINGTON, W. VA., TO IRONTON, OHIO (326.7 MILES BELOW PITTSBURG).

[Huntington gauge, 2.9 feet = 1 foot (12 inches) above low water (1895); Ironton gauge, 2 feet = 1.1 feet (13 inches) above low water (1895).]

		Inches.
Oct. 16.	Twelve Pole Bar	30
	Big Sandy Shoals	30
	Poge Shoals	30

IRONTON, OHIO, TO PORTSMOUTH, OHIO (355.2 MILES BELOW PITTSBURG).

[Ironton gauge, 2.9 feet = 1 foot (12 inches) above low water (1895); Portsmouth gauge, 2.3 feet = 1.1 feet (13 inches) above low water (1895).]

		Inches.
Oct. 16.	Fergusons Bar	30
	Greenup Shoals	24
	Jenatt Shoals	30
	Little Scioto Bar	30
	Bonanza Bar	24

PORTSMOUTH, OHIO, TO CINCINNATI (467.4 MILES BELOW PITTSBURG).

[Portsmouth gauge, 2.2 feet = 1 foot (12 inches) above low water (1895); Cincinnati gauge, 3.4 feet = 1.5 feet (18 inches) above low water (1881).]

		Inches.
Oct. 16.	Big Scioto Shoals	30
Oct. 17.	Conoconneque Bar	30
	Twin Creek Bar	36
	Quicks Run Bar	24
	Station Bar	30
	Brush Creek Island	24
	Pennyweight Bar	36
	Manchester Island	24
	Brooks Bar	24
	Charleston Bar	24
	Straight Creek Bar	30
	White Oak Bar	30
	Augusta Bar	24
Oct. 18.	Locust Bar	24
	Big Snag Bar	24
	Richmond Bar	20
	Nine Mile Bar	20
	Four Mile Bar	20
	Crawfish Bar	36

Depths on bars at low water of 1899, as reported by packet lines.

Ohio River below Cincinnati, Ohio.

[Compiled in office of Maj. Wm. H. Bixby, Corps of Engineers, U. S. Engineer Office, Cincinnati, Ohio.]

CINCINNATI, OHIO, TO LOUISVILLE, KY. (598 MILES BELOW PITTSBURG).

[Cincinnati gauge, 3.5 feet=1.6 feet above lowest water (1881). Louisville gauge, 4.8 feet=3.1 feet above lowest water (1884) in canal.]

		Feet.
Oct. 23.	Cullums	3.5
	Medoc	4
	Lawrenceburg	3.5
	Laughery	4
	Rising Sun	4
	Gunpowder	4
	Warsaw	3.5
	Craigs	4
	Locust	4
	Hoagland	4.5
	Grassy Flats	5

LOUISVILLE, KY., TO EVANSVILLE, IND. (783 MILES BELOW PITTSBURG).

[Louisville gauge, 3 feet=2 feet above lowest water (1856) (below locks). Evansville gauge, 1.5 feet=1.75 feet above lowest water (1895).]

		Feet.
Oct. 27–28.	Foot of locks	3
	Portland	4
	Falling Run	4
	Hughes	2.5
	Gravel Point	3.5
	Salt River	3.2
	Boston	4
	Brandenberg	3
	Haunted Hollow	3
	Richardson	4
	Blue River	2.5
	Peckenpaughs	3
	Flint Island	3.2
	Chenaults	2.5
	Brashears (Holts)	3
	Fulton, in cut	2.7
	Fulton, outside cut	1.7
	Troy Reach	3.5
	Andersons	4
	Rockport Bend	2.5
	Puppy Creek	4.5
	Owensboro Bend, head	3.2
	Enterprise Bend	5
	French Island, head	2.8
	French Island, foot	2.8
	Scuffleton, upper (Vanada)	2.8
	Scuffleton, middle (Falls Slough)	3.5
	Scuffleton, lower	3
	Three Mile, head	4
	Three Mile, foot	3.5
	Evansville	4

EVANSVILLE, IND., TO PADUCAH, KY. (920 MILES BELOW PITTSBURG).

[Evansville gauge 1.5 feet=1.75 feet above lowest water (1895). Paducah gauge, 1 foot=1.7 feet above lowest water (1895).]

		Feet.
Nov. 6–8.	Henderson Island, head	2.5
	Henderson Island, above dam	4
	Henderson Island, foot	4
	Henderson Bend	2.5
	Diamond Island, foot	3

		Feet.
Nov. 6–8.	Slim Island, foot	3
	Raleigh Bar	3
	Shawneetown	2.5
	Greens	2.5
	Tradewater River	3
	Tradewater Island chute	2.5
	Tradewater Crossing, Browns Point	3
	Tradewater Crossing, Westons	3
	Walkers	2.5
	Sisters	3
	Cumberland Island, head	2
	Cumberland Island, foot	3
	Cottonwood	3.5

PADUCAH, KY., TO CAIRO, ILL. (965 MILES BELOW PITTSBURG).

[Paducah gauge, 0.8 foot=1.5 feet above lowest water (1895). Cairo gauge, 3 feet=2 feet above lowest water (1871).

		Feet.
Nov. 2.	Little Chain, head	3.5
	Sharps Bar, near Ogdens	3
	Sharps Bar, foot	2.5
	Grand Chain	3.5
	Mound City towhead, head	3
	Mound City towhead, foot	2.5

Information furnished by the officers of the Louisville and Cincinnati Packet Company, the Louisville and Evansville Mail Company, and the Evansville, Paducah and Cairo Line.

Commerce of Ohio River in 1900.

Name of boat or company.	Terminal points.	Distance.	In commission.	Freight.	Passengers.
		Miles.	*Months.*	*Tons.*	
Coal shipments from Pittsburg	Pittsburg to Cairo	965	....	2,557,470	....
Monongahela River Consolidated Coal and Coke Co.	.....do	965	12	4,249,000	....
Steamer Lulu F	.....do	965	12	370	35
Steamer Avalon	Pittsburg to Louisville	598	9.5	15,796	4,232
Pittsburg and Louisville Transportation Co.	.....do	598	4	4,500	20,000
Pittsburg and Cincinnati Packet Line.	Pittsburg to Cincinnati	467	8	63,560	18,405
Steamer Cricket	Pittsburg to Ashland	320	5	861	952
Steamer Greenwood	Pittsburg to Gallipolis	267.5	8	10,400	7,680
Steamer Kanawha	.....do	267.5	10	16,000	14,860
Steamer Catharine Davis	Pittsburg to Point Pleasant	263.5	5	80,890	970
Steamer Urania	.....do	263.5	2	3,000	1,029
The Belmont Towing Co	Pittsburg to Pomeroy	249	8	7,000	269
Steamer Ben Hur	Pittsburg to Parkersburg	183.5	6.5	7,340	5,491
Steamer Mattie K	.....do	183.5	5	525	....
Steamer Lorena	Pittsburg to Marietta	171	9	8,300	5,600
Steamer Mayflower	Pittsburg to Rochester	25	2	....	10,500
Monongahela and Ohio River Transportation Co.	Pittsburg to Economy	17	4	....	3,900
Steamer Florence Belle	Pittsburg to McKees Rocks	3	9	6,750	100,800
Sharpsburg Sand Co	Davis Island Dam to East Liverpool.	39.5	3	12,500	....
Steamer Jack Osborn	Dam No. 2 to Dam No. 6	21	2.5	3,800	....
Steamer Sherrard	Toronto to Freemans Landing	1	11	....	44,390
Steamer T. M. Bayne	Steubenville to Wheeling	22.5	7	3,875	9,426
Steamer Nathaniel	Steubenville to opposite shore.	1	8.5	....	17,990
Steamer West End	Brilliant to Wellsburg	1	12	7,300	50,000
Steamer Conveyor	Martins Ferry to Wheeling	1.5	11	10,000	75,000
Steamer Lizzie Townsend	Martins Ferry to Bellaire	5.5	8	36,649	....
Steamer H. K. Bedford	Wheeling to Cincinnati	377	8.5	20,300	9,979
Steamer Wm. Duffy	Wheeling to Parkersburg	93.5	10	76,900	39,480
Steamer Telephone	.....do	93.5	4	1,500	800
Steamer Ruth	Wheeling to Sistersville	47.5	8.5	4,300	20,000
Steamer Leroy	Wheeling to Clarington	27	8	4,320	14,460
Steamer Buckeye	Wheeling to West Wheeling	1	12	....	42,360

Commerce of Ohio River in 1900—Continued.

Name of boat or company.	Terminal points.	Distance.	In commission.	Freight.	Passengers.
		Miles.	*Months.*	*Tons.*	
New Haven Towboat Co	Bellaire to Louisville	504	9	76,850	....
Steamer John C. Fisher	....do	504	10	93,850	149
Bellaire, Benwood and Wheeling Ferry Co.	Bellaire to Benwood	1	9	....	328,628
Steamer T. N. Barnsdall	Sistersville to Marietta	33.5	12	5,250	18,900
Steamer Nellie Bartlett	Sistersville to Syracuse	106.5	7	300	3,000
Steamer Orion	Sistersville to Tuels Landing	1	10	....	30,000
C. W. True	Matamoras to Friendly	1	10	....	27,680
Steamer Valley Belle	Marietta to Gallipolis	96.5	9	22,405	6,325
Steamer Pioneer City	Marietta to Williamstown	1	12	30,700	53,800
Huntington and St. Louis Towboat Co.	Parkersburg to Cairo	781.5	8.5	114,788	....
Big Sandy Towboat Co	Parkersburg to Cincinnati	283.5	5	10,712	....
Steamer Nina Paden	Parkersburg to Belpre	1	11	18,000	100,000
Steamer Little Queen	Millwood to Middleport	20	8.5	31,254	13,261
Jessie Towboat Co	Syracuse to Cincinnati	225	9	50,000	....
Steamer Klondike	Syracuse to Gallipolis	25.5	10	3,000	9,000
John Barrett & Son	Pomeroy to Cairo	717	10	162,000	....
Steamer Uncle Sam	Pomeroy to Carrollton	293	10	18,855	....
Convoy Towboat Co	Pomeroy to Louisville	350	....	244,280	....
Steamer Gate City	....do	350	7	180,000	....
Cincinnati, Portsmouth and Big Sandy Packet Co.	Pomeroy to Cincinnati	219	11	103,728	30,636
Steamer Champion No. 2	Pomeroy to Mason	1	12	22,000	175,000
A. Montgomery & Co	Point Pleasant to Cairo	701.5	9	102,157	....
Collins & Hartweg Co	Point Pleasant to Louisville	334.5	9	62,512	....
Kanawha and Ohio Co	....do	334.5	10	280,592	....
Steamer R. K. Wells	....do	334.5	4	37,040	28
Steamer Otto Marmet	Point Pleasant to Carrollton	277.5	12	117,700	....
Steamer John Mackey	Point Pleasant to Cincinnati	203.5	11	15,750	....
The Marmet Company	....do	203.5	12	168,500	....
Steamer Speedwell	....do	203.5	6	2,340	3,870
Steamer W. O. Hughart	....do	203.5	7	3,000	3,000
Steamer Neva	Point Pleasant to Gallipolis	4	10	2,856	7,321
Steamer Charley Stone	Point Pleasant to Fair Haven	1	11	33,000	6,600
Steamer Carrie Brown	Gallipolis to Huntington	39	10.5	23,950	16,545
Steamer Enos Taylor	....do	39	10	1,400	10,300
Steamer Guyandotte	....do	39	8	1,000	75
Steamer Champion	Gallipolis to Gallipolis Ferry	1	12	1,560	10,000
G. W. Bay	Proctorsville to Portsmouth	51	9.5	7,135	15,220
Steamer Arion	Proctorsville to Guyandotte	1	11	13,200	19,300
Ashland Coal and Iron Railway Co.	Huntington to Portsmouth	47.5	12	14,016	....
C. Crane & Co	Catlettsburg to Cincinnati	152	8	127,184	....
Steamer Wenona	Ashland to Coal Grove	1	12	....	91,250
Steamer Bob Ballard	Ashland to Ironton	5	12	366,389	....
Steamer Ironton	Ironton to Russell	1	11	11,582	118,410
Steamer Mary F. Golden	Portsmouth to Addyston	126	4	10,070	421
Steamer M. P. Wells	Portsmouth to Cincinnati	113	11	28,800	22,112
Steamer Charles B. Pearce	....do	113	10	47,914	28,940
Buena Vista Freestone Co	Buena Vista to Buena Vista	1	9	4,000	....
Steamer W. H. Whiteman	Manchester to South Manchester.	1	11	16,038	29,908
Coney Island Co	Ripley to Louisville	184	3.5	685	623,206
Steamer Proctor K. Smiley	Ripley to South Ripley	1	12	3,600	9,600
Steamer Whisper	Augusta to Bonds Ferry	1	11	1,000	4,100
Steamer Tacoma	Chilo to Cincinnati	36	11	2,248	18,470
Borches Sand and Stone Co	Moscow to Rising Sun	63	11	6,700	....
Steamer Ada V	Moscow to Cincinnati	26	12	214,300	....
Steamer Mary Stewart	New Richmond to Rising Sun	56	....	3,400	....
Steamer Vanguard	New Richmond to Aurora	47	0.8	19,150	....
Steamer New Richmond	New Richmond to South New Richmond.	1	8	15,000	14,000
Smith Coal and Sand Co	California to Addyston	12	12	120,000	....
New Orleans and Cincinnati Packet Co.	Cincinnati to Cairo	498	7	32,038	2,915
Memphis and Cincinnati Packet Co.	....do	498	7	15,721	2,717
Steamer L. H. Buhrman	Cincinnati to Paducah	453	6	15,000	....
Louisville and Cincinnati Packet Co.	Cincinnati to Louisville	131	12	115,264	111,858
Steamer Levi J. Workum	Cincinnati to Vevay	66	....	12,558	8,483
Steamer J. M. Grubbs	Cincinnati Harbor	....	10	40,000	....
R. H. Flemming	Newport to Ludlow	8	12	7,787	....
Chas. Kottmyer	Constance to Riverside	1	11	34,300	11,250
Steamer Swan	Aurora to Rising Sun	9	12	83	2,504
Louisville and Jeffersonville Ferry Co.	Carrollton to Leavenworth	117	12	....	995,967
Kentucky River Packet and Towboat Co.	Carrollton to Louisville	57	11	16,030	14,851

Commerce of Ohio River in 1900—Continued.

Name of boat or company.	Terminal points.	Distance.	In commission.	Freight.	Passengers.
		Miles.	*Months.*	*Tons.*	
Steamer Tom Ross	Carrollton to Madison	12	....	300	....
Kentucky and Indiana Ferry Co.	Madison to Milton	1	12	20,000	20,000
E. T. Slider	Utica to West Louisville	8	8	46,320	....
Bergenroth Bros	Louisville to Cairo	367	12	15,630	....
Louisville and Evansville Mail Co.	Louisville to Henderson	196.5	11.5	133,062	21,869
Steamer Alma	Louisville to Evansville	185	12	11,150	....
Steamer Rush	Louisville to New Albany	5	8	....	880
J. H. Hoffman & Co	Louisville Harbor	....	12	450,000	....
W. D. Crammond	Cloverport to Evansville	77.5	12	17,900	8,500
Robert Hornbrook	Rock Island to Paducah	207	10	39,305	12,638
Steamer Charley Curlin	Cannelton to Paducah	203	....	....	798
Steamer Fawn	Cannelton to Mount Vernon	102.5	8	6,000	8,300
Steamer Wabash	Newburg to Paducah	151	12	7,500	2,760
Steamer Ruby	Newburg to Uniontown	63.5	8	960	3,225
John Archbold	Newburg to Evansville	14	12	60,800	....
Evansville, Ohio and Green River Transportation Co.	Mouth Green River to Brooklyn.	148	12	86,740	....
Steamer Owensboro	Mouth Green River to Mount Vernon.	44.5	12	6,400	....
Ingle & Hornbrook	.....do	44.5	12	79,224	120
Green River Coal and Mining Co.	Mouth Green River to Evansville.	8	12	14,952	50
Aberdeen Coal and Mining Co.	Mouth Green River to Evansville.	8	12	34,615	....
Steamer Crescent City	.....do	8	11.5	1,587	4,124
Evansville and Bowling Green Packet Co.	.....do	8	12	7,000	7,500
Steamer Old Reliable	.....do	8	6	9,000	....
Evansville, Paducah and Cairo Line.	Evansville to Cairo	182	12	32,500	66,500
Dan Finnie	.....do	182	12	114,000	....
Steamer John F. Buckham	.....do	182	12	14,085	983
Steamer Woolfolk	.....do	182	....	17,800	....
Steamer Maggie Belle	Evansville to Brooklyn	140	10	950,000	....
Steamer Racket	Evansville to Paducah	137	2	20,075	....
Nashville and Evansville Packet Co.	.....do	137	7.5	7,500	3,700
Steamer Peter Hontz	.....do	137	6	16,800	225
Steamer Alfred D. Owen	Evansville to Shawneetown	65	12	9,659	10,800
Steamer Jewel	Evansville to Henderson	11.5	12	3,500	75,000
Illinois Central Rwy. Co	Evansville to Majors	4	....	305,959	24,507
Steamer Ruth	Henderson to Brooklyn	128.5	8	4,333	....
Steamer Georgia	Mount Vernon to Shawneetown.	28.5	12	800	1,500
Steamer Woodruff	Uniontown to Cairo	182.5	12	9,336	....
Ayer & Lord Tie Co	Mouth Wabash River to Cairo.	127	10	20,000	....
Steamer Eureka	Caseyville to Cairo	104	5	3,650	....
Steamer Kenton	Caseyville to Paducah	59	8	52,200	....
Steamer Waterloo	Golconda to Berry Ferry	1	12	2,000	6,000
Steamer Cora Belle	Smithland to Cairo	57	12	850,000	....
Steamer Dick Clyde	.....do	57	9	13,875	....
R. G. Rouse	.....do	57	12	27,000	50
St. Louis and Tennessee River Packet Co.	Paducah to Cairo	45	12	99,253	9,336
Steamer Bettie Owen	.....do	45	12	118,000	25,000
Steamer Geo. H. Cowling	Paducah to Metropolis	9.5	12	3,612	30,981
Illinois Central Rwy. Co	Paducah to Brooklyn	8	....	234,213	17,534
Total		....	....	14,054,322	3,881,588

Coal shipments from Pittsburg, Pa.

[Furnished by Mr. J. Frank Tilley.]

Month.	To Cincinnati.				To Louisville.			
	Trips.	Coal boats.	Coal barges.	Tons.	Trips.	Coal boats.	Coal barges.	Tons.
1900.								
January	39	30	142	105,130	14	197	85	233,050
February	35	35	147	112,680	16	190	85	226,400
March	53	45	304	206,910	29	217	185	306,050
April	14	....	103	55,620	9	....	95	51,300
June	36	....	204	102,000	18	34	378	221,300
July	12	....	10	5,000	4	....	75	37,500
November	39	22	235	147,800	31	291	102	331,530
December	16	14	97	65,680	11	138	53	159,720
Total	244	146	1,242	800,820	132	1,067	1,058	1,566,850

Total amount of coal shipped from Pittsburg to Cincinnati and Louisville	2,367.670
Add 949 flats of 200 tons each, shipped on scant water, not included above	189,800
Total	2,557,470

NOTE.—No shipments from Pittsburg to Cincinnati or Louisville in May, August, September, and October.

Shipments of June and July were in craft of light draft.

Trips to Cincinnati represent all the trips that left Pittsburg. Since consolidation of coal interests Cincinnati is first terminal point, some boats returning to Pittsburg after turning over tow to other boats which continued to Louisville.

Craft, full loaded, are based on coal boats of 950 tons and barges of 540 tons.

Comparative table showing coal shipments from Pittsburg during the ten years ending December 31, 1900.

Year.	To Cincinnati.	To Louisville.	Total.	Year.	To Cincinnati.	To Louisville.	Total.
	Tons.	*Tons.*	*Tons.*		*Tons.*	*Tons.*	*Tons.*
1891	1,065,705	1,828,047	2,893,752	1896	1,809,785	2,292,405	4,102,190
1892	914,430	1,384,864	2,299,294	1897	1,073,180	994,187	2,067,367
1893	829,878	1,534,523	2,364,401	1898	1,355,468	1,624,026	2,979,494
1894	1,153,765	1,300,022	2,453,787	1899	981,930	1,727,210	2,709,140
1895	1,036,661	1,357,212	2,393,873	1900	990,620	1,566,850	2,557,470

Commerce passing Davis Island Dam, Ohio River, during the calendar year 1900.

Vessels.	Ascending.				Descending.				Total freight.
	Lock.		Pass.		Lock.		Pass.		
	No.	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*Tons.*
Packets	75	8,587	167	27,191	64	10,505	180	22,685	68,968
Towboats	270	0	917	0	260	0	921	0	0
Model barges	5	0	16	0	6	3,000	27	24,300	27,300
Coal boats	170	0	407	0	22	0	1,219	1,107,100	1,107,100
Barges	554	0	1,960	7,689	364	111,058	2,042	1,098,589	1,217,336
Flats	352	1,620	675	18,420	445	66,750	955	143,250	230,040
Rafts	0	0	0	0	12	2,220	19	38,000	40,220
Miscellaneous	35	0	44	2,370	77	0	41	0	2,370
Total	1,461	10,207	4,186	55,670	1,250	193,533	5,404	2,433,924	2,693,334

Number of steamers in the freight and passenger traffic between Cincinnati and other ports, and total tonnage, compared for ten years.

Year.	Number.	Tonnage.	Year.	Number.	Tonnage.
Fiscal year:			Calendar year:		
1890-91	37	24,145	1896	25	15,032
1891-92	40	23,374	1897	27	15,881
Calendar year:			1898	25	14,677
1893	36	22,569	1899	29	16,311
1894	34	20,527	1900	28	15,618
1895	30	18,587			

List of Ohio River steamers destroyed in the year 1900, causes of destruction, and tonnage represented.

Name.	How destroyed.	Tonnage.
W. F. Nisbet	Sunk	576.86
Dick Brown	do	148.99
Total		725.85

Arrivals and departures of steamboats at the port of Cincinnati, Ohio.

Year.	Arrivals.				Departures.			
	From New Orleans.	From Pittspurg.	From other ports.	Total.	For New Orleans.	For Pittsburg.	For other ports.	Total.
Fiscal year:								
1891-92	23	204	1,958	2,185	23	202	1,963	2,188
Calendar year:								
1892	20	186	1,846	2,052	22	185	1,854	2,062
1893	17	120	1,754	1,891	17	120	1,757	1,894
1894	26	100	1,561	1,687	25	102	1,567	1,694
1895	24	a 52	952	1,028	26	a 46	911	983
1896	21	a 106	997	1,124	24	a 111	967	1,042
1897	32	a 91	827	950	27	a 94	827	948
1898	31	a 101	1,264	1,396	24	a 100	1,267	1,391
1899	25	a 61	1,600	1,686	19	a 66	1,527	1,612
1900	18	70	1,403	1,491	14	a 72	1,416	1,502

a Includes Wheeling, W. Va.

Schedule of rates on flour per barrel by rail and river from Cincinnati for ten years ending December 31, 1900.

Year.	To Pittsburg.		To Louisville.		To New Orleans.		To Memphis.	
	By rail.	By river.	By rail.	By river.	By rail.	By river.	By rail.	By river.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1891	24	15	15	15	49	35	....	....
1892	24	15	15	15	49	35	40	30
1893	24	15-20	15	15-10	49	35-30	40	30-40
1894	24	20	15	10	49	40	40	30
1895	20-24	20	15	10	49	40	40	30
1896	20-22	20	15	10	49	40	40	30
1897	10-24	20	a 15	10	49	40	a 40	30
1898	22-24	20	15	10	47½	40	a 26	30
1899	a 10	20	a 8-15	10	38½-39	40	26	30
1900	a 11	15-20	a 8	10	39	30-40	26	25-30

a Per 100 pounds.

REPORT OF MR. R. R. JONES, ASSISTANT ENGINEER, ON DIKE NEAR MOUTH OF TRADEWATER RIVER.

United States Engineer Office,
Cincinnati, Ohio, June 30, 1901.

Major: I have the honor to submit herewith a report of operations in construction of a dike near the mouth of Tradewater River, below Caseyville, Ky., for the fiscal year ending June 30, 1901:

* * * * * * *

ADDITIONAL DIKES FOUND NECESSARY.

Notwithstanding the scouring effect of the dikes built in 1889–1890 and 1893–1894, aided by the removal of sand and gravel, as above noted, the condition of the river near Caseyville and the mouth of the Tradewater River was still so bad in 1899–1900 that further construction was deemed necessary.

Under date of May 2, 1900, a project for the construction of a third dike below mouth of Tradewater River was submitted by the officer in charge, and this was approved by the Chief of Engineers May 9, 1900.

This project, which contemplated the expenditure of about $25,000 from funds available for the general improvement of the Ohio River, was a subproject of that submitted March 20, 1899, for the expenditure of the funds appropriated by the river and harbor act of March 3, 1899.

The dike (No. 3) contemplated under this project was to be about 1,400 feet in length, with a height of about 6 feet and width of 16 feet.

DIKE NO. 3, FISCAL YEAR ENDING JUNE 30, 1901.

The work of construction was advertised May 29, 1900, and the contract was let to Hampton G. Grainger July 27, 1900, at the following prices:

Stone, large size (6 to 10 cubic feet), per cubic yard in place	$1.50
Stone, ordinary (¾ to 1½ cubic feet), per cubic yard in place	1.00
Piling, per pile in place	3.00
Lumber, per 1,000 feet in place	25.00
Spikes, per 150 pounds in place	4.50
Earth excavation, per cubic yard	.25

The field work necessary for the proper location of the dike was begun August 18, and after identifying and tying in with several of the stations used in the survey of 1895 the line of the dike was laid out.

The contractor began actual work by driving piles August 24.

PILING.

Beginning at the Illinois shore, piles were driven in two parallel lines 10 feet distant from each other, the piles being spaced 10 feet apart on centers. The piles were from 12 to 16 inches in diameter at the large end and were driven from 10 to 18 feet into the river bed, being afterwards cut off at a level 6 feet above low water.

Beginning at a point about 186 feet from the Illinois shore, an opening 200 feet wide was left for the temporary passage of steamboats, but with this exception the piling was driven for the entire length of the dike, about 1,400 feet, and in all 246 piles.

STONE FILLING.

As soon as the pile driving had advanced sufficiently far to be out of the way of the other work, stone was brought in barges, and as expeditiously as possible was first spread along the entire length of dike for its full width. This made an apron protection calculated to resist scour while the dike was in process of completion. After this apron had been laid the stone was carried up as uniformly as practicable toward the full height of the dike. A total of about 8,602.6 cubic yards of stone was placed in the dike and shore riprap.

PASSAGE FOR STEAMBOATS.

The stone filled across the opening which had been purposely left for the passage of steamboats was carried up to a level of 4 feet below low water, thus leaving a channel through the dike with a clear depth of 4 feet at low water available for steamboats until such time as it shall appear proper to entirely close this gap.

BANK PROTECTION.

The bank adjoining the shore end of the dike, being ragged and inclined to cave, was graded off, beginning at the water line on a slope of 1 vertical to 1 horizontal, for a distance of 50 feet above and 50 feet below the axis of the dike. This slope was then protected by riprap extending to a height of about 21.25 feet above low water. Below the water line the stone was spread as evenly as possible over the natural surface of the steep bank in extension of the riprap laid above the water.

FLASHBOARDING.

In order to secure a rapid scour during the first season along the Kentucky side of the river, where the permanent channel must finally go, a line of flashboards 3 inches in thickness was spiked to the upstream side of the upstream row of piling with 8-inch spikes, the boarding being partly protected on both sides by the stone filling of the dike. By the time construction work was stopped by high water, November 27, 1900, the flashboarding had been attached to the piling for a height of 5 feet and for the entire length of the dike, excepting the 200-foot opening, while for a length of 700 feet the flashboards had been carried up to the full height of dike, viz, 6 feet above low water.

About 11,226 feet B. M. of lumber was placed in the form of flashboards.

SUSPENSION OF WORK.

Owing to a rise in the river, work was suspended November 27, 1900, at which time the following had been done:

Stone (ordinary) in place in dike	cubic yards..	8,602.6
Excavation, earth for shore protection	do....	192.5
Lumber, flashboarding, in place	feet B. M..	11,226
Piling in place	number..	246
Spikes in place	pounds..	300

The total amount earned by contractor was	$9,678.38
The total amount paid contractor was	8,710.54
Retained	967.84

The total cost originally estimated of the dike was $25,000 or less, as might be found necessary, but the low bids of the existing contract have already reduced the probable total cost to about $18,300. The rapid prosecution of work in 1900, together with the favorable water conditions of the following winter, may reduce the cost still further. It is proposed to resume work as soon as the conditions are favorable.

The work done during fiscal year ending June 30, 1901, was under the inspection of Mr. G. Fred. Allen, who has shown ability and close attention to his duties.

Respectfully submitted.

R. R. Jones, *Assistant Engineer.*

Maj. Wm. H. Bixby,
Corps of Engineers, U. S. A.

REPORT OF MR. WILLIAM M. HALL, ASSISTANT ENGINEER, ON REPAIRS OF DAM AT BROWNS ISLAND, NEAR STEUBENVILLE, OHIO.

United States Engineer Office,
Cincinnati, Ohio, May 22, 1901.

Major: I have the honor to submit the following report upon the examinations and repairs to the dam in the Ohio River at the head of Browns Island (60.5 miles below Pittsburg), during October and November, 1900.

* * * * * * * *

At the time of examination almost 300 feet of the dam next the Ohio shore, and 300 to 400 feet next Browns Island, protected by a growth of willows, was in a fairly good condition, and needed no repairs except patching a few small breaks in the paving. The second 300 linear feet from the Ohio shore had several breaks in the paving and many of the top ties badly rotted. The remaining 1,250 feet of dam had nearly all that part downstream of the center timber wall wrecked and washed away, except the lower ties and a part of the lower wall stringers. The ties were left fastened securely to the center wall. Two stringers were fast to lower end of the ties for more than half the length of the break and one for the balance of the distance, except almost 100 linear feet, where all the stringers were gone. It appears that the line of stringers left in place caused the stone and gravel bar which formed along and below them, thereby holding a pool of water from 2 feet to 4 feet deep at the exposed base of the center wall. This pool protected the center wall from the under scour of the waterfall over the dam, and probably to it is due the fact that the upper half of dam stood alone for so many years, doing good and efficient service. The center wall, upper wall, and intervening slope were intact, but the paving was broken in many places, and the top ties were badly rotted. For much of the distance the top ties had entirely given way at the ends, and the center wall was leaning downstream at an angle of three degrees to eight degrees with the perpendicular.

* * * * * * * *

The repairs as made consisted in replacing all the 6-inch by 12-inch ties on the upper slope of aforementioned 1,250-foot stretch of dam with new white-oak ties repaving all the breaks in paving; bracing the lower side of center wall with stru of 10-inch by 12-inch new white oak, 6 feet center to center; putting in timber bu heads at each end of the 1,250-foot break to prevent the break extending, and piling riprap stone up against lower side of center wall of dam. The 10-inch by 12-inch struts against the center wall of dam were arranged as shown in fig. No. 2 on drawing herewith. The heads of the braces were spiked against the second 10-inch by 12-inch stringer of the middle wall, and the foot spiked to the old lower ties. The struts are about 4½ feet long and have a batter of about 30 degrees with the horizontal. We picked up stone below the dam for filling in the pockets (see fig. No. 2) between the braces. We also spiked a horizontal waling strip of 3-inch by 10-inch white-oak timber to the old lower ties and against the foot of struts to more firmly hold the struts in place, and also with hope that it would assist to hold the riprap stone in place.

* * * * * * *

As directed by your letter of December 27, 1900, I visited the dam and inspected it on January 1, 1901, after the flood commencing November 22 had nearly subsided. I found the crest of the 1,250 feet which had been repaired partly covered with ice, and over the balance water was flowing from one-half inch to 6 inches in depth. The ice on the crest was from 1 foot to 5 feet wide, and from a few inches to 1 foot thick. Although I could not thoroughly examine all of the dam under such conditions, I could see it fairly well. The timber and paving which we placed in November did not appear to be at all injured. The only apparent damage by the flood was to the stone filling which had been piled up against the lower side of the center wall. In some of the pockets between the struts (fig. No. 2) the riprap was hardly disturbed at all, but in many others it was down to the level of the lower ties, or about 3 feet below the crest of the dam. Under the conditions of water and ice there at time of inspection it was not practicable to make measurements for an estimate of the amount of stone which had been washed away, but from observation I thought it about 100 cubic yards, or nearly 25 per cent of the amount placed. I do not consider the damage serious, and if future floods are no more injurious I think the dam will stand in present condition for three or four years, and possibly double that time. However, it will no doubt be wise to have it inspected from time to time and have any small breaks in paving or timber promptly repaired. After a single stone in the paving is moved out of place a break thus started is rapidly extended by a flood. I learned while repairing this dam that such breaks are more liable to be started by fishermen and camping parties pulling up paving stones than by the force of water during winter and spring floods.

The quantities of work done in making the repairs are as follows.

Old timber removed (about)	feet B. M..	15,000
Stone and gravel filling placed under paving	cubic yards..	120
Paving laid	square yards..	385
New white-oak timber purchased, framed, and placed	feet B. M..	19,496
Drift bolts and spikes used	pounds..	1,435
Riprap piled against lower side of center wall	cubic yards..	435

The cost of the work was as follows:

For labor	$352.01
Cost of timber and drift bolts	487.16
Cost of new tools purchased	46.14
Examination and superintendence by assistant engineer and suboverseer..	140.00
Travel expense of assistant engineer and suboverseer	55.07
Total expenditures for work	1,080.38

From an analysis of the above figures I deduce the unit costs of the work done as follows:

Classification.	Cost per unit for—				Total cost per unit.
	Materials.	Tools, etc.	Labor.	Superintendence, etc.	
Timber in place (including bolts), per 1,000 feet B. M..	$24.98	$1.18	$7.77	$5.90	$39.83
Old timber removed, per 1,000 feet B. M.			1.00		1.00
Relaying paving, per square yard			.23	.10	.33
Riprap and stone and gravel filling, per cubic yard		.04	.16	.08	.28

Respectfully submitted.

Wm. M. Hall, *Assistant Engineer.*

Maj. Wm. H. Bixby,
Corps of Engineers, U. S. A.

REPORT OF MR. WILLIAM M. HALL, ASSISTANT ENGINEER, ON REPAIRS TO MARIETTA ISLAND DAM.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, May 25, 1901.

MAJOR: I have the honor to submit the following report upon the repairs to the dam across the back channel of the Ohio River at the head of Marietta Island (169.0 miles below Pittsburg), made during November and December, 1900, and January, 1901.

* * * * * * *

Figure No. 1 of the accompanying drawings shows a typical section of the dam as originally built. By examining the drawing you will see that the dam was 24 feet wide, with an apron attached 10 feet wide, except at the ends, where the apron was only 6 feet wide. The body of the dam consisted of four walls of longitudinal stringers laid skin to skin, and bound together by 6-inch by 12-inch ties. The upper wall of stringers was composed of six or seven layers of 10-inch by 12-inch timbers; the second wall was composed of seven layers of 10-inch by 12-inch timbers; the third wall of three layers of 6-inch stringers on edge, and the lower wall of two layers of 10-inch by 12-inch timbers. There were also from two to four layers of 10-inch by 12-inch sticks under the lower edge of the apron. The two upper walls, 5 feet 6 inches center to center, were bound together by four sets of ties, the bottom set 12-inch by 12-inch mudsills; 12 inches above them a set of 6-inch by 12-inch ties running entirely through the dam; 2 feet above these long ties a set of 6-inch by 12-inch by 6-foot ties, and at top a set of 6-inch by 12-inch ties flush with the top paving. The second and third walls were 11 feet center to center and the third and fourth walls 7 feet center to center. These three walls were bound together by the long 6-inch by 12-inch ties near bottom and a set of 6-inch by 12-inch ties at top. The wall at the tail of the apron was made fast to the main dam by a sheeting of 4-inch by 12-inch timbers. All the ties were 6 feet center to center except the top ties, which were 12 feet center to center. All the timbers of the dam were spiked together with three-fourths inch driftbolts. The cribs thus formed were filled with stone and gravel, paved on top flush with the top ties, and the paving grouted with Portland cement grout. The profile of the section was as follows: The top of the upper wall was 6 feet above low water. The paving sloped upward from that point, with a rise of 12 inches for 5 feet, to the second wall, which formed the crest of the dam. From the second wall the paving sloped down, with a fall of 6 feet in 18 feet, to the upper edge of the apron. The apron was built with a horizontal top. When we commenced the repairs along the 541 feet of broken section in the middle of dam about all of the paving had been washed out. Along 478 feet of the break nearly all the stone and gravel filling had been washed out. For the greater part of the distance the filling in pockets between the two upper walls was out down to the lower 6-inch by 12-inch ties, even so at places where all the timber stringers were intact to the top of the walls. In the pockets below the crest wall the filling and the bed of the river bottom bottom had scoured out to a depth of 1 foot to 4 feet below those ties. The top ties were off all along the break. At one place on the upper wall the stringers were off for three layers; for about 150 feet two layers were off, and for about 250 feet one layer was off. The second wall, which formed the crest of the dam, had a little more timber off than the upper wall. The 6-inch wall under lower slope was almost entirely gone for about 300 feet; about 100 feet more of it was badly damaged, and the balance in place. All the long 6-inch by 12-inch bottom ties were in place, and a part of the stringers at their lower end fast to them. The apron was destroyed in two places. For about 200 feet it was fast to the lower 6-inch by 12-inch ties, but was lifted up on lower edge so as to give it a slope upstream as much as 30 degrees in some places. In short, the upper wall and crest walls were badly broken, and all that part of timber and stone construction below the crest wall was almost entirely destroyed, except the long bottom ties and the stringers fast to lower ends. It is quite probable that this line of stringers caused the formation of the stone and gravel bar found along and below them, which made a pool of water at foot of crest wall. I think this pool, into which the waterfall poured, protected the two upper walls from the under scour, and thereby saved the dam from entire destruction.

In making repairs, under your instructions, we cut down the remaining timber work at the ends of the break and partly rebuilt it in the middle. Figure No. 2 of drawings shows a typical section of dam as rebuilt along the middle, and the top outline of accompanying longitudinal elevation of dam is the same as the new profile along the crest.

In making repairs, where timber was lacking it was replaced by old timber tak from other parts of the dam, the only new material used being round driftbolts five-eighths inches in diameter by 12 inches and 18 inches long. About 1,144 pounds of these bolts were used.

The repairs made in November were started on the Marietta Island side and proceeded toward the West Virginia shore. The repairs done in December and January were started on the West Virginia side and proceeded toward Marietta Island. In doing the work along the parts where timber was to be removed it was taken out as rapidly as possible by one gang of men and immediately reframed by another gang and replaced in that part of dam requiring building up.

Each of the steps made in profile of dam made a place subject to more violent action of water than other parts; therefore, to prevent new breaks, a timber bulkhead was put in under each of the steps and extended down to the bottom ties. After replacing the timber the refilling with stone and gravel was commenced, and that work followed by the repaving.

When we suspended work in January all the timber requiring removal had been taken out of the dam. The replacing of timber had all been done except some eight or ten sticks. From the island side the filling with stone had been done for about 212 feet and the repaving for about 140 feet. From the West Virginia side the refilling had been done for about 138 feet and the repaving for about 130 feet. The part in middle of dam which was not refilled is about 191 feet long, and the part not repaved about 241 feet long. We did not do that work in December and January for the reason that to do the work properly at the stage of water we had at that time, or at any stage much higher than 3.5 feet, would have necessitated the cofferdam process. To have done the work under that process would have cost two or more times as much as if done at a 3.5-foot or lower stage. Moreover, to the repairs made in November there was but little damage done by the flood of November 22 to December 15, and therefore it is probable that the dam as it was left in January, unless raked by an ice or timber gorge, will not be greatly damaged by the spring floods.

The quantities of work done in making the repairs are shown in tabulated form, as follows:

Old timber pulled out of dam	feet B. M.	36,350
Old timber reframed and replaced in dam	do	30,280
Old driftbolts straightened and reused	pounds	700
New driftbolts used	do	1,144
Stone and gravel filling placed	cubic yards	500
Paving laid	square yards	581

The above quantities also include the patching of paving at the ends of the dam.

The cost of doing the above work, making examinations, reports, etc., was as follows:

Labor	$722.50
Driftbolts	44.55
Tools	25.26
Hire of boat and teams	22.50
Superintendence	290.00
Travel expense	105.21
Total	1,210.02

From an analysis of the above figures I deduce the following unit costs of the work done as follows:

Classification of quantities.	Cost per unit for—					Total cost per unit.
	Boat and teams.	Material.	Tools.	Superintendence.	Labor.	
Removing old timber, per 1,000 feet B. M.	....	....	$0.20	$2.75	$5.50	$8.45
Reframing and replacing timber, per 1,000 feet B. M	$0.15	$1.47	.20	2.75	7.19	11.76
Paving, per square yard	.01	....	.01	.10	.20	.32
Stone and gravel filling, per cubic yard.	.02	....	.01	.29	.38	.70

Respectfully submitted.

Wm. M. Hall, *Assistant Engineer.*

To Maj. Wm. H. Bixby,
Corps of Engineers, U. S. A.

REPORT OF MR. R. R. JONES, ASSISTANT ENGINEER, ON REPAIRING GREAT MIAMI EMBANKMENT, LAWRENCEBURG, IND.

United States Engineer Office,
Cincinnati, Ohio, June 30, 1901.

Major: I have the honor to submit herewith a report of operations in repairing the Great Miami embankment at Lawrenceburg, Ind., for the fiscal year ending June 30, 1901:

This work is designed to protect the city of Lawrenceburg, Ind., from overflow by back water during the flood stages of the Ohio and Great Miami rivers.

Lawrenceburg is situated on the Ohio River at the mouth of the Great Miami, about 491 miles (by survey 1900) below Pittsburg. It is the county seat of Dearborn County, Ind., and has a population of about 5,500.

A detailed account of the location of the city and work done on the embankment in former years is contained in Appendix E E, pages 2331–2332, Annual Report Chief of Engineers for 1899.

There has been a total appropriation of funds for the construction and repair of the Great Miami embankment (including the allotment of March 3, 1899), as follows:

By city, State, and railroads	$104,884.30
By United States	75,000.00
Total	179,884.30

The balance of funds available at the beginning of the fiscal year was $3,040.47.

This amount was expended under the contract with John W. Scott, dated August 14, 1899, by filling in earth on portions of the old canal bed on the inside of embankment of the North Division levee, so far as the remaining funds would permit.

Work was carried on from July 1 to July 10, 1900, when it was stopped by the exhaustion of funds available.

The material placed in the work during the fiscal year ending June 30, 1901, has been as follows:

Earth in place in bed of old canal at the foot of inside slopes, cubic yards, net	1,530

The total earth placed along inside slopes and in bed of old canal at the foot (inside) embankment, under contract with John W. Scott, dated August 14, 1899, has been as follows:

	Cubic yards.	
	Gross.	Net.
During fiscal year ending June 30, 1900	65,076	60,017
During fiscal year ending June 30, 1901	1,700	1,530
Total	66,776	61,547

The cost of this work has been as follows:

61,547.4 cubic yards in place, at 22⅞ cents	$14,078.97

The earth filling was completed July 10, but as that season of the year was not favorable for the sowing of grass seed, it was deferred until the following spring, when all the new fill on slopes and canal beds was thickly sown with a mixture of blue grass and white clover, at the rate of 4 bushels to the acre.

The North Division levee, under recent projects, has been reenforced, beginning at the intersection of the Fair Grounds levee and extending about 6,915 linear feet northwardly therefrom along the inner slopes, earth filling as follows:

	Linear feet.
During fiscal year ending June 30, 1899	2,000
During fiscal year ending June 30, 1900	4,915
During fiscal year ending June 30, 1901	-----
Total	6,915

In addition to this filling along the old slopes the bed of old canal at the foot of slope has, under the present project, been filled for about a length, as follows:

	Linear feet.
During fiscal year ending June 30, 1900	3,600
During fiscal year ending June 30, 1901	100
Total	3,700

The work thus far done has added greatly to the strength of the original levee.

During the fiscal year ending June 30, 1901, the work has been done under the inspection of Mr. Bert Ross, who has been faithful and efficient in the performance of his duties.

Respectfully submitted.

R. R. Jones, *Assistant Engineer.*

Maj. Wm. H. Bixby,
Corps of Engineers, U. S. A.

REPORT OF MR. R. R. JONES, ASSISTANT ENGINEER, ON REPAIRING EMBANKMENT AT SHAWNEETOWN, ILLINOIS.

United States Engineer Office,
Cincinnati, Ohio, June 30, 1901.

Major: I have the honor to submit herewith a report of operations in repairing the embankment at Shawneetown, Ill., for the fiscal year ending June 30, 1901:

Shawneetown is situated on the Ohio River about 848 miles below Pittsburg. It is the county seat of Gallatin County, Ill., and has a population of about 2,100.

A detailed account of the special conditions of the work is contained in Appendix E E, pages 2332–2334, Annual Report Chief of Engineers for 1899.

There has been a total appropriation of funds for the construction and repair of the levees at Shawneetown (including the allotment of March 3, 1899) as follows:

By city, State, and railroads	$271,418
By United States	89,000
Total	360,418

The river and harbor act of March 3, 1899, made an allotment of $25,000 to be expended in repairs to the Shawneetown embankment. There was also a balance of $1,576.33 left over from the work under the agreement of September 17, 1898, so that the total amount of funds available for work under present project was $26,576.33.

The present project contemplates the reenforcement of the embankment at the worst places by filling along the inner slopes, the new material thus added to be about 50 per cent of the old section; driving sheet piling along the toe of the embankment on the outside to cut off the underground leakage; also a small amount of riprap protection.

Proposals for repairing and strengthening this embankment were asked for under advertisement dated June 17, 1899. The bid of F. F. Harrison was the lowest, as follows:

Earth in place, per cubic yard	$0.25
Sheet piling in place, per linear foot	6.50
Stone riprap in place, per cubic yard	1.75

Owing to the failure of the successful bidder to enter into contract, the contract was, with the permission of the Chief of Engineers, assumed by Mr. C. H. Glandorf, his bondsman, who carried it on until the completion of present project:

During the fiscal year ending June 30, 1901, work (net) was done as follows:

Earth in place, cubic yards	32,632.4
Sheet-piling protection in place, linear feet	270
Stone riprap in place, cubic yards	300

Under the agreement of Mr. F. F. Harrison, carried on by his bondsman, Mr. C. H. Glandorf, work has been done as follows:

	1900.	1901.	Total.
Earth in place, cubic yards	4,400	32,632.4	37,032.4
Sheet-piling protection in place, linear feet	1,830	270	2,100
Stone riprap in place, cubic yards	....	300	300

The work was delayed by bad weather and insufficient plant of the contractor, but was completed under present project December 17, 1900, with the exception of the sowing of grass seed, which was deferred until a more favorable season.

The sowing of the grass seed was done in the early spring of 1901, with a mixture of blue grass and white clover, at the rate of 4 bushels to the acre.

The embankment has been strengthened and repaired on the inside under present project at the following localities:

	Linear feet.
Sections 55 to 64	900
Sections 80 to 85 + 50′	550
Sections 95 + 85′ to 103	715
Sections 183 to 192 + 50′	950
Total	3,115

In addition to the above the outside of the North levee was filled out to the original section and protected by riprap for a distance of 260 feet.

The embankment, where it has been strengthened and repaired, is in excellent condition, but there still remains not less than 2 miles of embankment which does not possess adequate strength.

During the fiscal year the work was done under the inspection of Mr. H. E. Frye and Mr. Bert Ross, respectively, who were faithful and efficient in the performance of their duties.

Respectfully submitted.

R. R. Jones, *Assistant Engineer*

Maj. Wm. H. Bixby,
Corps of Engineers, U. S. A

REPORT OF MR. R. R. JONES, ASSISTANT ENGINEER, ON EXTENDING SHORE ENDS OF DIKES AND BANK PROTECTION NEAR EVANSVILLE, IND.

United States Engineer Office,
Cincinnati, Ohio, June 30, 1901.

Major: I have the honor to submit a report of operations in extending the shore ends of dikes, and repairing bank protection, near Evansville, Ind., about 783 miles below Pittsburg, for the fiscal year ending June 30, 1901:

EXTENSION OF SHORE ENDS OF DIKES.

The extension of shore ends of dikes was in the nature of repairs to existing work which had been done under project dated June 26, 1896, and approved by the Chief of Engineers August 22, 1896.

An extension of the dikes proper, and the riprapping of the banks immediately adjoining them, was rendered necessary by the rapid caving of the steep banks since the original construction of the dikes. These higher banks had receded to such an extent that the dikes were left without proper connection with the shore, and the value of the work already constructed was thus impaired.

The extension, etc., contemplated refilling low portions of the dikes near the shore, the grading of steep banks where required to a slope of 1 vertical to 2 horizontal, and the placing of a stone riprap protection along the surface of banks thus prepared.

This work was advertised April 18, 1900, and a contract dated June 19, 1900, was made with Charles McNutt and Sanders C. Hornbrook.

The amount to be expended on this work was $3,500.

Work was begun July 13, 1900, and completed under the contract on August 11, 1900; stone being placed at the old curved dike and at dikes Nos. 2, 3, and 6 of the 1896–97 construction.

The total material placed was as follows:

Stone	2,407.06 cubic yards.

The total payment to contractor for this work was $3,490.24.

The extension and riprap protection will, it is hoped, preserve the dikes from the danger which threatened them.

The work, with the exception of a small amount at Nos. 2 and 6, was done under the immediate supervision and inspection of Mr. W. A. Christian, assistant engineer. The final work at Nos. 2 and 6 was under the inspection of Mr. Newton Tebow.

REPAIRING BANK PROTECTION.

The work originally done under the head of "Bank protection" was for the purpose of arresting the caving of the banks, and so preventing a "cut-off" which threatened the peninsula which lies mostly opposite and above Evansville, Ind.

This work was done under projects dated June 19 and July 14, 1896, and as modified July 9, 1897. These projects were approved, respectively, August 18, 1896, and July 22, 1897.

The repairs to bank protection contemplated the replacement of piles which had been carried away, and refilling with earth, brush, and stone at such points as should be deemed the most necessary for the preservation of existing work.

The work was advertised April 18, 1900, and a contract dated June 19, 1900, was made with Charles McNutt and Sanders C. Hornbrook, at the following prices:

Piles	each..	$4.00
Oak slabs	per cubic yard..	1.00
Brush	do....	.70
Stone	do....	1.25

The amount to be expended was $1,200.

Work was begun in August, 1900, and was completed under the contract, September 28, 1900.

The following material was placed in the repairs:

Piles	number..	40
Oak slabs	cubic yards..	47.6
Brush	do....	209
Stone	do....	676.8

The total amount paid the contractors was $1,199.90.

The work was done under the inspection of Mr. Frank W. Phillips.

Respectfully submitted.

R. R. JONES, *Assistant Engineer.*

Maj. WM. H. BIXBY,
Corps of Engineers, U. S. A.

REPORT OF MR. E. J. CARPENTER, ASSISTANT ENGINEER, ON WORK OF THE OHIO RIVER DREDGES DURING THE CALENDAR YEAR 1900.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, June 30, 1901.

MAJOR: I have the honor to submit the inclosed reports of operations of the U. S. dredges *Ohio* and *Oswego* and of the hired dredging plants of H. S. Brown and William A. Kirk for the calendar year 1900, with tabular statements showing cost, amount of excavation, etc., at the various places where dredging was done.

The dredges remained in winter quarters in the Kentucky River at Carrollton until March 8, when they were brought to Cincinnati for repairs, the principal items of which were the remodeling of the dredge *Oswego* and providing a new boiler for the *Ohio*. Repairs were begun on April 2, and it was expected that the *Ohio* and the scows would be ready for work by the middle of June, but owing to delay in the construction and delivery of the new boiler the dredge was not ready until August 1. As the stage of water continued too high for work in the lower river, where the dredges were to be operated, the fleet remained at Cincinnati until August 8, the crews being employed mainly on repairs of the *Oswego*.

In remodeling the *Oswego* the dredge was fitted with a new crane with swinging cylinder and an almost complete set of new machinery, in which wire ropes were substituted for chains, and heavy spuds were provided for holding up the forward end of the dredge when at work, following the general plan and as far as possible duplicating the new machinery which has been in successful service on the dredge *Ohio* since 1896.

General plans for the *Oswego's* new machinery and drawings and specifications for the crane had been prepared, and a contract for the construction of the new crane had been made during the previous season. Detailed drawings for the machinery and contracts for its construction were made early in the spring, and the work of reconstruction was prosecuted as rapidly as possible, but owing to the great quantity of general work with which all machine shops and foundries were crowded at this time, the contractors who were building the crane, as well as those who were to furnish the large number of steel castings required for the hoisting machinery, were unable to make their deliveries on time, so that the dredge was not ready when the approach of low water made it necessary to move the fleet to the lower river, where dredging for the season had been planned. It was therefore necessary to take the *Oswego* down the river in an unfinished condition, the crane and part of the hoisting machinery following the dredge to Mound City, and the repairs being completed at Brooklyn, Ill., where the dredge was afterwards operated very satisfactorily.

The cost of repairing and remodeling the *Oswego's* hull and building new crane, spuds, and machinery, amounting to $13,908.89; the cost of the *Ohio's* new boiler, $3,328.50; and the new launch machinery, $775, have not been taken into account in the statement of cost of work for 1900, because they are not properly chargeable to any one year.

The dredging planned for the season of 1900 was a continuation of the improvement at Mound City, Ill., with Brooklyn Harbor and Golconda, Ill., to be taken up in case work at Mound City should be interrupted by high water from the Mississippi, as had frequently happened before.

The work of the dredges during the season was as follows:

MOUND CITY, ILL., 959 MILES BELOW PITTSBURG.

Under the project approved April 3, 1899, for the expenditure of $25,000 appropriated by the river and harbor act of March 3, 1899, for dredging and diking at Mound City, Ill., the dredge *Ohio* was employed to continue the work of the two previous years, widening the new channel from the middle of the river opposite the towhead to the Mound City wharf.

Dredging was begun on August 21 and continued, with some interruptions from high water, until October 6, when work was stopped by a rise from the Mississippi, which backed into the Ohio River, making the depth too great for further operations at this place.

The effect of the dredging was to add 75 feet to the width of the new channel for a distance of 1,400 feet at the upper cemented gravel lump, the depth being 6 feet below low water except over an area 35 feet wide and 200 feet long, where the cemented gravel, too hard for excavation to grade, was scraped off to a depth of from 2 to 4 feet below low water, preparatory to blasting.

Most of the excavated material was dumped in the upper entrance to the old Kentucky chute, in order to divert the river current into the new channel. This, in connection with the dredging, established the low-water channel for the season on the new channel line.

During September a survey was made of that part of the river which includes the dikes and the new channel from the towhead to the Mound City wharf. A progress map showing location of dredging, dumpage, etc., is herewith.

Excavation made August 21 to October 6.

	Cubic yards.
Gravel and sand	23,193
Cemented gravel	5,258

The expenditure required for a channel with 6 feet depth at low water past Mound City is now estimated as follows:

For a channel 300 feet wide, 6 feet deep at low water.

Excavation in mid river above towhead, about 6,000 feet long: 150,000 cubic yards gravel and sand, at 12 cents		$18,000
Excavation from mid river opposite towhead to Mound City wharf, a distance of about 6,000 feet:		
150,000 cubic yards gravel and sand, at 12 cents	$18,000	
40,000 cubic yards cemented gravel, at 35 cents	14,000	
		32,000
Excavation from Mound City wharf to mouth of Cache River, a distance of about 6,500 feet: 150,000 cubic yards gravel and sand, at 12 cents		18,000
For dredging		68,000
For dikes now under contract		20,000
Total		88,000

For a channel 600 feet wide, 6 feet deep at low water.

Excavation in mid river above towhead, about 6,000 feet long: 400,000 cubic yards gravel and sand, at 12 cents	$48,000
Excavation from mid river opposite towhead to Mound City wharf, a distance of about 6,000 feet:	
400,000 cubic yards gravel and sand, at 12 cents	48,000
120,000 cubic yards cemented gravel, at 35 cents	42,000
	90,000
Excavation from Mound City wharf to mouth of Cache River, a distance of about 7,000 feet: 400,000 cubic yards gravel and sand, at 12 cents	48,000
For dredging	186,000
For dikes now under contract	20,000
Total	206,000

The most important work is the completion of the dredging through the cemented gravel lump and the construction of the new dike and extension of the long spur dike from the Kentucky shore, as it is probable that after these improvements are completed a large percentage of the loose gravel and sand will be scoured away by the river current thus concentrated in the new channel, which would reduce all the above estimates of quantities of loose gravel and sand to be removed.

The cost of this most important work is as follows:

Dredging channnel 300 feet wide and about 6,000 feet long from mid river opposite towhead to Mound City wharf	$32,000
Construction of dikes now under contract	20,000
	52,000

It is impossible to make a close estimate for the cost of dredging at Mound City, because the stage of water at that point is influenced by the Mississippi as well as the Ohio River, and consequently there is never a reasonable certainty that the work of dredging or dike construction can be carried on without costly delays from high water. It is, however, believed that the dike construction and dredging through the cemented gravel bar can be completed for the amount stated.

HILLERMAN LANDING, ILL., 939 MILES BELOW PITTSBURG.

While on the way from Mound City to Brooklyn, Ill., the dredges stopped at Hillerman to remove a number of rocks obstructing the only low-water landing in this neighborhood on the Illinois shore.

The obstructions are blocks of cemented gravel, forming a reef, which extends diagonally upstream from the lower end of the landing. All were removed except a few on shore and a number of submerged ones, which the dredges could not reach, owing to insufficient depth of water on the bar in which they are embedded.

The rocks removed were dumped on left of the channel near the Kentucky shore, 6 feet below low water.

Work done October 11.

Rocks removed (18)	tons	19.5

BROOKLYN HARBOR, ILL., 923 MILES BELOW PITTSBURG.

After work at Mound City was stopped by high water, the dredges proceeded to Brooklyn Harbor, where they were employed under the project approved April 1, 1899, for expenditure of the $10,000 for dredging the harbor at Brooklyn, Ill., appropriated by the river and harbor act of March 3, 1899.

As the dredging at this place in 1898 and 1899 at the lower end of the landing was done at a high stage of river, about the limit at which work was possible, some rocks were unavoidably left between cuts and a number of rocks, too large to enter the dredge dippers, were pushed aside and could not be removed. The stage of river being favorable, this area was dredged over, and the rocks and gravel were removed to a depth of a little more than 6 feet below low water.

The upper end of the landing was cleared of a deposit of mud, gravel, logs, etc., and the landing was extended downstream by dredging off the cemented gravel bar at the lower end, where the wreck of a model barge was also destroyed and removed.

The area dredged, 6 feet below low water, is as follows: At the upper end four cuts were made, covering a width of 175 feet for a distance of 340 feet; on the cemented gravel bar an area averaging 230 feet for a distance of about 600 feet, the extreme width being 260 feet and extreme length 800 feet, and along the shore above the bar two cuts aggregating 40 feet for a length of 900 feet.

The material excavated was scattered along the Kentucky shore opposite Brooklyn, to left of channel.

During November a survey was made of the river in front of Brooklyn, including the area under improvement and the bar below the town.

A progress map showing location of dredging, dumpage, etc., is herewith.

Excavation made October 12 to November 23.

Cemented gravel	cubic yards..	17,422
Mud, logs, etc	do....	8,368
Logs and snags removed (48)	tons..	57.1
Rocks removed (9)	do....	39.8
Model barge wreck	number..	1

A rapid general rise of the river prevented dredging after November 23, and as it seemed probable that work would be stopped indefinitely, the dredges were moved to a safe harbor in the Tennessee River at Paducah, when on December 5, after the boats had been put in order for winter, the crews, with exception of 4 men, were furloughed without pay. On the 10th, 2 additional men were furloughed, and the fleet was left in charge of 1 engineer and 1 cranesman, the usual force required to care for it during the winter.

The balance of the last appropriation for general work on the Ohio River having been about exhausted, the plan for operation of the plant for the season of 1901 was necessarily limited to points having unexpended special allotments for dredging, viz: Evansville, Ind., Golconda, Ill., Brooklyn, Ill., and Mound City, Ill.

All these places being on the lower river, where the stage of water is usually too high to permit work earlier than the first of August, the dredges have been obliged to lie idle, remaining in their winter quarters at Paducah, Ky.

A contract has been made with the Smiley Towboat Company to furnish a dredge tender when required, and various repairs have been made preparatory to beginning work as soon as the stage of the river will permit; but owing to continued high water no dredging has thus far been possible.

WORK OF HIRED DREDGING PLANTS IN 1900.

Under proposals opened June 15, 1900, for hire of dredging plants for service on the Ohio River, contracts were made with Wm. A. Kirk, of Madison, Ind., and H. S. Brown, of Quincy, Ill., to furnish one plant each; a plant consisting of one dipper dredge, three dump scows, and one towboat for tender, all complete with crews, fuel, and necessary appliances. The original contracts provided for only eight hours' service per day, but as it later appeared that the interest of the Government, as well as that of the contractors, would be promoted by increasing the length of daily service, supplemental contracts were made with Mr. Kirk and Mr. Brown, providing for working their plants, with double or triple crews, for sixteen or twenty-four hours per day.

MADISON, IND., 553 MILES BELOW PITTSBURG.

Under the project approved April 10, 1899, for expenditure of $20,000 appropriated by the river and harbor act of March 3, 1899, for dredging the harbor at Madison, Ind., to 6 feet below low water, the Wm. A. Kirk dredging plant was employed at this place.

The plant was operated eight hours per day from July 18 to September 19 under contract dated June 26, 1900, and sixteen hours per day, with double crews, from September 20 to November 28 under supplemental contract dated August 29, 1900.

From July 18 to November 17 the dredge was employed almost entirely in removing the bar in the river below the public wharf, the object being to deepen the channel in such manner as to cause scour along the front of the city landing. The area dredged at this place has a width of 510 feet and an extreme length of 1,140 feet, the average length being 970 feet. The depth excavated was 6 feet below low water, with the exception of 30 by 200 feet which was dredged 5 feet below low water while the river was too high to reach grade.

During high water in August an area 30 by 550 feet was dredged 5 feet below low water along the city front just above the upper end of the wharf; and from November 17 to 24 this work was continued 6 feet below low water, making the total length 1,120 feet, of which the middle portion for 320 feet was 60 feet wide and the remainder 30 feet wide.

The excavated material, which was fine sand at the lower bar, and gravel and sand at the wharf, was dumped on the Kentucky shore close below the root of the dike.

A progress map showing location of dredging, dumpage, etc., is herewith.

Excavation made July 18 to November 24.

Gravel and sand	cubic yards	50,638
Sand	do	53,349
Logs removed (1)	tons	1.6

After November 24, the river became too high for work, and on the 28th, as there was no prospect of early resumption, the plant was discharged.

EVANSVILLE, IND., 783 MILES BELOW PITTSBURG.

Under the project approved April 1, 1899, for expenditure of $20,000 diverted by the river and harbor act of March 3, 1899, from the unexpended balance of the appropriation of June 3, 1896, for dredging along the city front of Evansville, Ind., the Brown plant began operations on July 19, and continued until September 25, widening the channel in front of the city landing.

The area dredged, 6 feet below low water, was 160 feet wide for a length of 1,050 feet, with a less width for 350 feet farther, the area averaging 160 feet wide and 1,200 feet long.

The excavated material—mud, sand, etc.—was dumped on the Kentucky shore, close below the root of the long training dike, and below dike No. 6.

A progress map showing location of dredging, dumpage, etc., is herewith.

Excavation made July 19 to September 25.

Mud, gravel, sand, etc	cubic yards	21,695
Logs removed (2)	tons	3

After the Brown plant had dredged out the approach to the Evansville landing, it was sent up the river to Falling Run bar, just below Louisville, in compliance with urgent requests from various packet lines and steamboat interests, for sufficient dredging to open low water channels through the obstructing sand bars between Louisville and Evansville.

The plan of operation was to deepen the low-water channels by making a single cut through the sand reef, throwing the excavated material into bank on one side in such manner as to act like a dike, and increase scour by directing the river current through the channel. No dumpage banks were made in mid river or in the coal-boat channels, except where the material was light enough to be dissipated by the next rise.

It was necessary to prosecute this work as rapidly as possible, without confining the operation of the plant to eight hours per day, because the dredge, while at work on these bars, often lay in the low-water channel, where it was an obstruction to navigation, and because success in opening a channel often depends on continuous work after the cut is begun.

The plant was operated until October 31 under contract for eight hours' service per day, and from November 1 to 27 under supplemental contract for sixteen hours per day.

The points at which the Brown plant was thus employed were as follows:

FALLING RUN BAR, 604 MILES BELOW PITTSBURG.

One cut 35 feet wide and 520 feet long, 4 feet below low water, was made through the reef near the Kentucky shore, the excavated material being banked on the left.

Excavation made October 1 to 4.

Sand	cubic yards	1,640

HUGHES BAR, 609.5 MILES BELOW PITTSBURG.

One cut 35 feet wide, 1,100 feet long, 4 feet below low water, was made through the reef in the crossing from Kentucky toward the Indiana shore, the excavated material being thrown into bank on left of the cut.

Excavation made October 5 to 8.

Sand	cubic yards..	3,040

BOSTON LANDING, 628 MILES BELOW PITTSBURG.

One cut 35 feet wide, 300 feet long, 4 feet below low water, was made through the reef in the channel along the Indiana shore, the material excavated being banked on left of the cut.

Excavation made October 9.

Sand	cubic yards..	640
Snags removed (3)	tons..	18.1

RICHARDSON LANDING, 645 MILES BELOW PITTSBURG.

One cut 35 feet wide, 900 feet long, 4 feet below low water, was made through the reef in the crossing toward the Kentucky shore, above mouth of French Creek. The material excavated was thrown into bank on right of the cut.

Excavation made October 10 to 12.

Sand and gravel	cubic yards..	1,650

BLUE RIVER ISLAND BAR, 655.5 MILES BELOW PITTSBURG.

One cut 35 feet wide, 1,100 feet long, 4 feet below low water, was made in the crossing toward the Indiana shore at foot of the upper island. Excavated material was thrown into bank on right of the cut.

Excavation made October 12 to 16.

Sand and gravel	cubic yards..	2,890

OIL CREEK BAR, 685.5 MILES BELOW PITTSBURG.

One cut 35 feet wide, 750 feet long, 4 feet below low water, was made in the crossing to the Kentucky shore above the mouth of Oil Creek, Indiana, the excavated material being banked on the right.

Excavation made October 17 to 19.

Sand and gravel	cubic yards..	1,500

CHENAULT REACH, 688.5 MILES BELOW PITTSBURG.

One cut along the Indiana shore, 35 feet wide, 2,540 feet long, 3 feet below low water, begun in October, was finished November 11, the material being banked on right of the cut.

A progress map showing location of dredging, dumpage, etc., is herewith.

Excavation made October 20 to November 11.

Mud and hard gravel	cubic yards..	10,975
Snags removed (7)	tons..	12.6

CLOVERPORT, KY., 705 MILES BELOW PITTSBURG.

On November 11, while traveling from Chenault Reach to Fulton Bar, the dredge stopped for about two hours at Cloverport, where a load of stone which had been thrown overboard by private parties to save a barge sunk in the middle of the channel opposite the town landing was scattered into deep water and leveled off to a depth of about 3 feet below low water, reducing height of the stone pile 3.5 feet.

Excavation made November 11.

Loose rock .... cubic yards..	100

FULTON BAR, 718 MILES BELOW PITTSBURG.

A cut 35 feet wide, 3 feet below low water, and 2,185 feet long was made on right of the low-water channel, the excavated material being thrown into bank on the right side of the cut.

A progress map showing location of dredging, dumpage, etc., is herewith.

Excavation made November 12 to 24.

Sand and gravel .... cubic yards..	9,750

After the dredging at Fulton was completed the river rose so much as to prevent further work of this character, and the plant was sent back to Evansville, where as the rise continued, it was discharged on November 27.

E. J. Carpenter,
Assistant Engineer.

Maj. Wm. H. Bixby,
Corps of Engineers, U. S. A.

OHIO RIVER DREDGING STATEMENT FOR 1900.

[Exclusive of time and cost for remodeling dredge *Oswego*, April 9 to October 23; cost of new boiler for *Ohio*, $3,328.50; and of new machinery for launch, $775.]

Dredges in commission.

TIME.

Time at work.	Days.	Time lost.	Days.
Dredging cemented gravel	13.6	Sundays	16
Dredging gravel and sand	7	Holidays	1
Dredging mud, logs, etc	6.8	Traveling	4.5
Removing logs and snags	1	High water	4.7
Removing rocks	.6	Coaling	1.3
Removing wrecks	.1	Accidents	21.4
Total	29.1	Total	48.9

Total in commission, 78 days.

WORK.

Nature of work.	Per day of work.	During the season.
	Cu. yds.	*Cu. yds.*
Cemented gravel excavated	1,667.6	22,680
Gravel and sand excavated	3,313.3	23,193
Mud, logs, etc., excavated	1,230.6	8,368
Total excavation for the season	....	54,241

	Number.	Tons.
Logs and snags removed	48	57.1
Rocks removed	27	59.3
Wrecks removed	1	

COST.

Equipment for the season	$1,085.95
Towing and fuel for the season	6,082.51
Repairs for the season	2,523.40
Salaries for the season	4,072.14
Total cost for the season	13,764.00

Dredges out of commission.

TIME.

	Days.
In ordinary	130
Annual repairs	35
Total	165

COST.

Salaries in ordinary	$2,457.64	
Total in ordinary		$2,457.64
Salaries during annual repairs	$2,210.12	
Annual repairs (shop bills, materials, etc.)	1,621.24	
Total cost of repairs		3,831.36
Total out of commission		6,289.00
Cost per day in ordinary (including superintendent's pay)		18.90

Cost of work, including all expenditures, in 1900.

[With exception of remodeling dredge *Oswego*, boiler for *Ohio*, and new launch machinery.]

Dredging cemented gravel	$9,371.84
Dredging gravel and sand	4,823.75
Dredging mud, logs, etc.	4,685.92
Removing logs and snags	689.12
Removing rocks	413.46
Removing wrecks	68.91
Total expenditure in 1900	20,053.00

Cost per unit.

Per cubic yard of excavation	$0.369

The day of work is for actual operation of two dredges with four dump scows and one towboat for tender, making good every hour lost by accident or otherwise.

The towboat *Jim T. Duffy, Jr.*, chartered as dredge tender, was paid $45 per day while operating above, and $47 per day while below, Louisville, Ky., this amount covering the cost of the boat, with outfit, crew, and fuel for the towboat and dredges, except that all cost of coal in excess of 5 cents per bushel was repaid by the Government.

The "total expenditure" includes all outlay in 1900 properly applicable to the cost of dredging, except the cost of remodeling the dredge *Oswego*, a new boiler for the *Ohio*, and new machinery for the sounding launch.

Location and description of work.

Place.	Miles from Pittsburg.	Date.	Days of work.	Logs and snags.		Rocks.	
				Number.	Tons.	Number.	Tons.
		1900.					
Brooklyn Harbor, Illinois	923	Oct. 12-Nov. 22	9.6				
Do	923	Oct. 24-Nov. 23	6.8				
Do	923	do	1	48	57.1		
Do	923	Oct. 15-Nov. 13	.3			9	39.8
Do	923	Nov. 8	.1				
Hillerman Landing	939	Oct. 11	.3			18	19.5
Mound City, Ill	959	Aug. 21-Oct. 2	7				
Do	959	Sept. 24-Oct. 6	4				
Total			29.1	48	57.1	27	59.3

Location and description of work—Continued.

	Wrecks.	Excavation.				
		Gravel and sand.	Cemented gravel.	Mud, logs, etc.	Per day of work.	Cost per cubic yard.
	Number.	*Cu. yards.*	*Cu. yards.*	*Cu. yards.*	*Cu. yards.*	
Brooklyn Harbor, Illinois			17,422		1,814.8	$0.379
Do				8,368	1,230.6	.559
Do	1					
Mound City, Ill		23,193			3,313.3	.208
Do			5,258		1,314.5	.524
Total	1	23,193	22,680	8,368		

	Expenditures.						
	Removing logs and snags.	Removing rocks.	Removing wrecks.	Dredging gravel and sand.	Dredging cemented gravel.	Dredging mud, logs, etc.	Total for 1900.
Brooklyn Harbor, Illinois					$6,615.42		$6,615.42
Do						$4,685.92	4,685.92
Do	$689.12						689.12
Do		$206.73					206.73
Do			$68.91				68.91
Hillerman Landing		206.73					206.73
Mound City, Ill				$4,823.75			4,823.75
Do					2,756.42		2,756.42
Total	689.12	413.46	68.91	4,823.75	9,371.84	4,685.92	20,053.00

Work of hired dredging plant under contract with William A. Kirk.

Place.	Miles from Pittsburg.	Date.	Days of work.	Logs and snags.		Gravel and sand.	Sand.	Cost per cubic yard.	Total cost.
		1900.		*No.*	*Tons.*	*Cu. yds.*	*Cu. yds.*		
Madison, Ind	553	July 18–Nov. 24	83-⅞			50,638		$0.149	$7,587.44
Do	553	Oct. 1–Nov. 17	82-⅞				53,349	.140	7,497.01
Do	553	Nov. 8	⅛	1	1.6				9.05
Total			166⅞	1	1.6	50,638	53,349		15,093.50

Work of hired dredging plant under contract with H. S. Brown.

Place.	Miles from Pittsburg.	Date.	Days of work.	Logs and snags.		Mud, gravel, sand, etc.	Sand.	Loose rock.	Cost per cubic yard.	Total cost.
		1900.		*No.*	*Tons.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*		
Falling Run bar	604	Oct. 1–4	3⅛				1,640		$0.204	$334.50
Hughes bar	609.5	Oct. 5–8	4⅞				3,040		.154	468.30
Boston Landing	628	Oct. 9	⅜				640		.119	76.46
Do	628	do	⅞	3	18.1					19.11
Richardson Landing	645	Oct. 10–12	2⅞			1,650			.168	277.15
Blue River Island bar	655.5	Oct. 12–16	5⅛			2,890			.168	487.42
Oil Creek bar	685.5	Oct. 17–19	2⅜			1,500			.165	248.48
Chenault Reach	688.5	Oct. 20–Nov. 11	31			10,975			.269	2,962.70
Do	688.5	Oct. 27	⅛	7	12.6					47.79
Cloverport, Ky	705	Nov. 11	⅛					100	.287	28.67
Fulton bar	718	Nov. 12–24	23⅛			9,750			.230	2,245.93
Evansville, Ind	783	July 19–Sept. 25	57⅞			21,695			.270	5,862.92
Do	783	July 27–Aug. 22	⅛	2	3					100.87
Total			133⅜	12	33.7	48,460	5,320	100		13,160.30

REPORT OF MR. R. R. JONES, ASSISTANT ENGINEER, ON SURVEY OF OHIO RIVER, MARIETTA TO MOUTH OF BIG MIAMI RIVER.

United States Engineer Office,
Cincinnati, Ohio, June 30, 1901.

Major: I have the honor to submit herewith a report on survey of Ohio River, from Marietta to mouth of Big Miami River, for the fiscal year ending June 30, 1901.

REPAIRS TO SURVEY OUTFIT, ETC.

The two quarter boats and steamer *Edna*, which had been brought up from their winter quarters at Carrollton, Ky., about the middle of June, 1900, were repaired and generally renovated, preparatory to the season's work. To quarter boat No. 2 a small upper cabin was added, containing a room for office and three staterooms, while the old office in lower cabin was converted into a stateroom. Some additional windows were also placed in bunk and mess rooms. Quarter boat No. 1 was supplied with better facilities for storing ice and fresh meats, and a floor laid over the old one in upper cabin. The machinery of the *Edna* received necessary repairs, and both quarter boats and the *Edna* were thoroughly painted in from two to three coats. Both quarter boats were supplied with wire screens and window shades. As these repairs were completed the field parties were organized and sent up the river to resume the work on which they had been respectively engaged during the preceding season.

THE SEASON'S PROJECT, FISCAL YEAR 1900.

The work done during the preceding fiscal year (ending June 30, 1900) was confined to extending the base lines, precise levels, and water slopes as far down the river as the time available for such work would permit, while the soundings, cross section, and topographical work was confined to islands, ripples, and other portions of the river which were assumed to present the most difficult phases for improvement.

As a rule the pools where deep water might reasonably be expected were, from motives of economy, left for future consideration.

THE SEASON'S PROJECT, 1900, FISCAL YEAR 1901.

Quarter boat No. 2.

When work was resumed in July, 1900, the first move was to fill in all those gaps on the river which had been purposely omitted (delayed) for the reasons above given, and after that to extend the work toward its final destination. With this purpose in view quarter boat No. 2 left Cincinnati, Ohio, July 16, and was towed up the river to Spencers Landing, W. Va., near the foot of "Half Way Island" (sometimes called James), about 6 miles above Parkersburg, W. Va. The party, consisting of 26 men all told, reached Spencers Landing July 18, and field work was immediately commenced on soundings of the river, cross sections of its banks, and the topography of the shore and upper banks, beginning at a point 178.3 miles below Pittsburg, Pa.

Work was continued by the party on quarter boat No. 2 until on October 23 it had reached Walkers Landing, Ohio, 361.6 miles below Pittsburg, Pa. The quarter boat was then towed to Andersons Ferry, just below Cincinnati, Ohio, and about 477 miles below Pittsburg, which point it reached October 24, and proceeded to take soundings and topography on the stretch of river most likely to be affected by the construction of a movable dam just below Cincinnati. On November 7, this work having been completed to Petersburg, Ky., 493.3 miles below Pittsburg, the point previously designated as the end of the survey, the quarter boat was once more towed up the river to Walkers Landing, Ohio, reaching there November 9. From November 9 to December 8 the detail work was carried down as far as near Wrightsville, Ohio, 382.4 miles below Pittsburg. The inclemency of the season, and more particularly the stage of the river, which was too high for rapid or economical survey work, made a further continuation of the field work at this time undesirable. Accordingly the quarter boat was brought to Cincinnati December 10, the party disbanded, and the boat itself taken to winter quarters in the Kentucky River.

QUARTER BOAT NO. 1.

The field parties employed in the running of base lines, precise levels, and water slopes were organized for work and left Cincinnati, Ohio, July 23, 1900. The entire party embraced 30 men all told, including the crew of the small steamer *Edna*. The boat was towed up to Brammers Landing, Ky., reaching this point July 24, the party beginning work July 25 at a point about 332.7 miles below Pittsburg.

From this point the base lines, precise levels, and water slopes were carried through to connection, at the head of Nine-mile Bar, about 453.7 miles below Pittsburg, with the work done in season of 1899, covering 121 miles of this class of work. The work was completed to this point by base line and precise level parties on October 4.

The parties were then rearranged so as to permit of the taking of soundings, cross sections, and topography, and this work was completed by them from a point a little below Eight-mile Dike and about 455.8 miles below Pittsburg, to the head of Culloms Ripple, 472.8 miles below Pittsburg, this point being reached October 23. Between October 23 and November 7, the parties on quarter boat were engaged in clearing the base line run during the preceding season between Culloms Ripple and Petersburg in order to facilitate the work by quarter boat No. 2 on the stretch between Andersons Ferry and Petersburg, and in perfecting the water slopes over parts of the river on which a high stage had prevailed during the preceding season's work.

On November 7, quarter boat No. 1 was towed to Augusta, Ky., reaching there November 8.

Between November 9, when work was begun at this point, and December 8, soundings, cross sections, and topography were taken from 425.4 to 441.2 miles below Pittsburg, the work being greatly retarded during the month of December by reason of high water and inclement weather.

Quarter boat No. 1 was brought to Cincinnati, Ohio, December 10, 1900, the field parties disbanded, and the quarter boat and the steamer *Edna* taken to winter quarters in the Kentucky River.

FIELD WORK COMPLETED DURING FISCAL YEAR ENDING JUNE 30, 1901.

The base lines and precise levels were run from a point near Greenup, Ky., 332.7 miles below Pittsburg, to the head of Nine-mile Bar, 453.7 miles below Pittsburg, 121 miles. The water slopes were taken over the same stretch of river and also over some portions which had been subject to high stages during the preceding season's work.

Of the soundings of the Ohio River, cross sections of its banks, and topography of its shores and upper banks, there were completed in all 191.57 miles of main river, besides 3.54 miles of tributary streams. During this work the boats traveled over about 253 miles of river, not taking into account the long runs made necessary while being moved down to the lower end of the survey and back again. The work included the taking of 100,763 soundings.

The table herewith given shows the location of work done, the number of miles covered, and the number of soundings taken at each locality.

SURVEY MARIETTA TO BIG MIAMI.

Soundings and topography completed during season of 1900.

The locality.	Below Pittsburg on main base.		Main channel.		Back channel or dike.		Total.	
	From—	To—	Length.	Soundings.	Length.	Soundings.	Length.	Soundings.
	Miles.	*Miles.*	*Miles.*		*Miles.*		*Miles.*	
Halfway (or James) Island to Neals (or Coles) Island	178.30	180.22	1.92	904	....	....	1.92	904
Neals (or Coles) Island to Parkersburg	182.03	183.61	1.58	721	....	....	1.58	721
Parkersburg to Blennerhassett Island	184.24	185.30	1.06	385	....	....	1.06	385
Blennerhassett Island to Newberry Island	189.91	193.37	3.46	1,542	....	....	3.46	1,542
Newberry Island to Mustapha Island	194.19	195.61	1.42	314	....	....	1.42	314
Mustapha Island to Belleville bar	197	200.26	3.26	1,443	0.18	31	3.44	1,474
Belleville bar to Belleville Island	200.91	202.91	2	754	....	....	2	754
Belleville Island to Swan bar	204.37	212.30	7.93	3,532	....	....	7.93	3,532
Swan bar to Buffington Island	213.82	215.45	1.63	510	....	....	1.63	510
Buffington Island to Sand Creek bar	217.22	220	2.78	880	....	....	2.78	880

Soundings and topography completed during season of 1900—Continued.

The locality	Below Pittsburg on main base.		Main channel.		Back channel or dike.		Total.	
	From—	To—	Length.	Soundings.	Length.	Soundings.	Length.	Soundings.
	Miles.	*Miles.*	*Miles.*		*Miles.*		*Miles.*	
Sand Creek bar to Old Town towhead	221.22	224.41	3.19	1,034	....	....	3.19	1,034
Old Town towhead to Goose Island	225.82	227.18	1.36	468	....	....	1.36	468
Goose Island to Letart Island	230.15	233.56	3.41	1,299	....	....	3.41	1,299
Letart Island to Weaver shoals	235.82	236.56	.74	268	....	....	.74	268
Weaver shoals to Wolf bar	237.75	241.45	3.70	1,258	....	....	3.70	1,258
Wolf bar to Lower Siegrist bar	242.26	242.75	.49	187	....	....	.49	187
Lower Siegrist bar to Upper Pomeroy	243.82	248.22	4.40	2,059	....	....	4.40	2,059
Upper Pomeroy to Lower Pomeroy	248.64	249.34	.70	200	....	....	.70	200
Lower Pomeroy to Middleport	249.56	250.91	1.35	413	....	....	1.35	413
Middleport to Eight-mile Island	251.26	256.34	5.08	1,902	....	....	5.08	1,902
Eight-mile Island to Point Pleasant-Gallipolis	258.07	264.07	6	2,558	....	....	6	2,558
Gallipolis to Raccoon Island	268.56	274.07	5.51	2,142	....	....	5.51	2,142
Raccoon Island to Straight ripple	275.56	283.37	7.81	3,201	....	....	7.81	3,201
Straight ripple to Dogham bar	284.61	300.07	15.46	6,908	....	....	15.46	6,908
Dogham bar to Guyandotte-Ashland	301	303.04	2.04	981	....	....	2.04	981
Ashland to Hanging Rock-Greenup	320.41	329.37	8.96	8,181	....	....	8.96	8,181
Greenup to below Vanceburg	336.60	382.45	45.85	22,046	.75	78	46.60	22,124
Augusta to Moscow	425.45	441.23	15.78	14,083	....	....	15.78	14,083
Nine-mile bar to Culloms ripple	456.23	472.76	16.53	10,634	1.41	235	17.94	10,869
Culloms ripple to Petersburg	477.11	493.28	16.17	9,474	1.20	138	17.37	9,612
Total	....	....	191.57	100,281	3.54	482	195.11	100,763

TOTAL BASE LINES, PRECISE LEVELS, AND WATER SLOPES.

The total length of Ohio River over which base lines, precise levels, and water slopes have been carried during progress of surveys from Marietta to Pittsburg (fiscal years ending June, 1897 and 1898) and survey from Marietta to Big Miami River (fiscal years ending June 30, 1900 and 1901) has been as follows:

	Miles.
Pittsburg, Pa., to Marietta, Ohio	172
Marietta, Ohio, to Petersburg, Ky	321.3
Total, Pittsburg, Pa., to Petersburg, Ky	493.3

The portions of the river between Marietta, Ohio, and Petersburg, Ky., over which the soundings, cross sections, and topography are as yet unfinished, are as follows:

	Miles.
Below Vanceburg, Ky., to Augusta, Ky	43
Moscow, Ohio, to Nine-Mile Bar, Kentucky and Ohio	12.51
Total unfinished	55.51

It is proposed to send out one quarter boat with a full complement of men to complete the above 55.51 miles during the season of 1901-2, beginning about the middle of July, 1901, if the stage of river then proves favorable for the work.

FIRST SECTION.

The section of survey on quarter boat No. 1, which includes base lines, precise levels, and water slopes (also reorganized for soundings, etc.) was under the efficient supervision of Mr. J. Nelson Caldwell, assistant engineer. He was assisted by Mr. E. W. Buell, surveyor, having charge of precise levels; Mr. F. A. Bone, surveyor, in charge of water-slope levels, and Mr. Houston Jones, surveyor, in charge of triangulation and location of bench marks.

SECOND SECTION.

The section of survey on quarter boat No. 2, which included soundings, cross sections, and topography, was under the efficient supervision of Mr. Clinton B. Harris, surveyor. He was assisted by Messrs. G. A. Loeb and John B. Delany, surveyors in charge of cross section and topographical work, and Messrs. H. E. Frye and Joel H. Pillsbury, surveyors in charge of cross-section levels.

All of the above-named gentlemen showed marked energy and ability in the performance of their various duties.

PLATTING OF MAPS OF SURVEY.

The platting of field work already done was carried on by a considerable force after the return of the various parties from the season's work.

Up to the close of the fiscal year about 338 miles of the surveys of the Ohio River have been traced.

Of this 338 miles, 172 miles include the river between Pittsburg, Pa., and Marietta, Ohio, which was surveyed in the years 1896–97. The remaining 166 miles include portions of the river between Marietta, Ohio, and Petersburg, Ky.

There now remains to be traced of such portions of the river as have been already surveyed and platted 99.8 miles, besides the portions of river (55.5 miles) over which the field work has not yet been entirely completed.

The tracing of maps already platted will be continued, and the additional field work now proposed will be platted, as far as possible, while the parties are still in the field by a small force at this office.

A diagram map showing progress made on survey during the fiscal year ending June 30, 1901, is herewith inclosed.

Respectfully submitted.

R. R. Jones, *Assistant Engineer.*

Maj. Wm. H. Bixby,
Corps of Engineers, U. S. A.

G G 2.

OPERATING SNAG BOAT ON THE OHIO RIVER.

The act of Congress of September 19, 1890, as modified by that of June 3, 1896, provided for yearly appropriations of $50,000 for this work. For phraseology of these acts and further details see the Annual Report for 1896, Part IV, page 2093. These yearly appropriations allow of continuous operations and of proper repair and care of plant much more fully than in former years, when such work had to be done out of irregular and insufficient allotments from appropriations for the improvement of the Ohio River.

At the close of the last year the U. S. snag boat *E. A. Woodruff* was at Ironton, Ohio, 325 miles below Pittsburg, and left that place on July 2, 1900, for Cincinnati, arriving on the 4th and remaining until the 9th, completing various minor repairs. On July 10 she proceeded downstream for removal of obstructions between Cincinnati and the mouth of the river; arrived at Cairo, Ill., on the 28th, and the next day began her return trip, reaching Cincinnati on August 22, and after necessary repairs to paddle wheels, etc., resumed her upriver trip on the 28th. Owing to the extremely low water she could only ascend as far as Pomeroy, Ohio, 248.5 miles below Pittsburg, from which place she returned on September 6 to Ashland, Ky., 71 miles below. From this date until the end of the month the snag boat and her two steel flatboats, separately manned and equipped, were continuously employed in blasting and removing rock from the channel for 5 or 6 miles above and below Ashland.

During October and November the *Woodruff* lay up near Ashland because of low water, and her crew was used in connection with small hired boats on the removal of low-water obstructions, as reported below under the head of "Hired Plant."

No change occurred in the river conditions above Cincinnati until November 27, 1900, when a rise permitted the snag boat to depart for the lower river. En route she removed from the Government ice pier at Portsmouth, Ohio, about one acre of saw logs, trees, and small drift; reached Cincinnati on the 28th, where necessary repairs to engines, etc., were in progress until December 4; then returned direct to Pittsburg with a special view of removing several wrecks in that vicinity—mostly coal boats sunk in November—arriving December 8, when a high stage was running and a second fleet of coal tows was descending the river.

The coal shipments of November and December, 1900, were unusually disastrous, one coal company alone having sunk 32 boats between Pittsburg and Portsmouth, Ohio. Some of the sunken boats were unloaded and raised by the owners, and written abandonment was procured as rapidly as possible of others lying in or near the channel which were liable to endanger navigation. December 10 the snag boat left Pittsburg, removing on her way down the river 1 coal-boat wreck under the Pittsburg Point bridge, 3 at or near Montgomery Island, 1 steamboat hull at Yellow Creek, the remains of 13 coal boats near Guyandotte, W. Va., 3 coal boats at Walkers Landing, 1 wreck at Ludlow, Ky., just below Cincinnati, and at the end of the month was in port at Cincinnati.

January 2, 1901, the *Woodruff* went to Locust bar, 35 miles above Cincinnati, to remove the remains of the steamer *W. F. Nisbet*, sunk by ice in January, 1900, and on the 5th had blasted, cut up, and removed out of the way the entire wreck except a small part of the bottom buried in mud. The removal of this wreck had been postponed from time to time when the snag boat was passing because of the request of the owners for opportunity to remove what could be saved, and because of the difficulty of procuring abandonment due to a subsequent change of ownership. After a short detention at Cincinnati by uncertain conditions of river and weather, the snag boat again started downstream on the 9th for work below Louisville; but, on consultation with lower-river packets, found that the channel was entirely clear of obstructions, and therefore returned to Cincinnati, where she went out of commission January 18.

While in winter quarters preparations were made and work was in progress for annual repairs of the boat until May 1, when a full crew was reshipped to connect up machinery generally and put the boat in order for resumption of work as soon as the river should fall to a suitable stage. All repair work being completed on the 25th, a trip was made to Louisville, Ky., in connection with the removal of obstructions near that point, and on return the boat proceeded to Pittsburg for work on abandoned wrecks and other obstructions previously reported in that vicinity.

The snag boat arrived at Pittsburg June 4, and lay there a few days awaiting a suitable working stage of river, meanwhile going down to Davis Island dam on the 11th and 12th to assist in repairs of the dam—straightening the large iron props supporting the wickets and doing other work. On the 12th the snag boat removed the remains of a sand boat, sunk on May 4, at Brunots Island. On the 13th the boat was headed downstream, and performed her regular work until reaching Portsmouth, Ohio, where she stopped for work on the ice pier, removing on the 25th a drift pile caused by the pier of about three-fourths acre area, averaging about 15 feet in depth, and including hundreds of saw logs carried out by recent floods from the Big Sandy, Guyandotte, and Kanawha rivers. After removing the drift pile the boat lay by until the 27th, when the river fell sufficiently below the tops of the pier to permit of commencing work on the removal of the two outer cribs, so far decayed and damaged as to be dangerous to navigation, which work was in progress at the end of the month.

Hired plant.—In order to take advantage of the favorable conditions for clearing the low-water channel, arrangements were completed in October, 1900, for utilizing the snag-boat crew and outfit on such work up river as long as a continuance of low water would permit; in accordance with which three small boats, the *Levi*, *Thealka*, and *Cricket*, all of light draft and suitable capacity for subsisting crews, were hired and fitted out with necessary tools and appliances, and manned chiefly from the regular snag-boat crew. Meanwhile the United States snag boat itself was laid up at Ashland and used as headquarters until low-water work was suspended, on November 22 and 23, by a considerable rise of river, which made it unadvisable to keep the boats longer in service, and they were accordingly called in and discharged.

The gasoline boat *Levi*, hired at Madison, Ind., arrived at Ashland September 28, 1900, and after fitting out started, on October 1, for Addison, Ohio, 260 miles below Pittsburg, where she arrived on the 3d, and began the blasting and removal of rocks from the bar just below, continuing the work until the 22d, up to which date there had been removed 1,217 rocks—2,592 cubic yards. The boat then proceeded upstream and engaged in similar work at Letart Falls, 233 miles below Pittsburg, and at Shortcreek, W. Va., 80 miles below Pittsburg, where the party finished work on November 1, and then moved downstream, stopping at various localities for longer or shorter intervals, according to the demands of the channel, the principal points of work being Powhatan Point and Captina and Mustapha islands. Work at the latter place was suspended on November 21 by the approaching rise, and the *Levi* returned to Ashland, removing snags found on the way, and was discharged on November 25, 1900.

The steamboat *Cricket* was hired at Ashland, Ky., on October 1, 1900, and after fitting out began on the same day the removal of obstructions in that vicinity, continuing until the 11th, when the party proceeded to Conoconneque bar, 364 miles below Pittsburg. The removal of rocks and one wrecked barge from this bar was completed on the 16th, and the *Cricket* was then sent to Cincinnati to take out the wreck of the steamer *Dick Brown*, a serious danger to navigation which had caused much complaint. On completing this work the boat returned upstream, removing snags en route, and on October 31 arrived at Letart Falls, 233 miles below Pittsburg. The party continued operations in this vicinity until November 13, having broken up and removed 336 rocks, averaging 3 cubic yards each. All beneficial work being completed, the boat moved below and cleared the channel at Siegrists ripple and Wolfs bar, near Pomeroy, finishing the work on the 19th, then worked downstream to Ashland, and was discharged on November 26, 1900.

The steamboat *Thealka* was hired on October 5, 1900, and after fitting out started on the 6th direct for Middleport, Ohio, 249.5 miles below Pittsburg, with a special view to clearing away a great amount of logs, drift, etc., which had accumulated around the ice piers at this place and at Pomeroy, Ohio, 2 miles above. Work at Middleport was completed on October 23, 143 snags having been taken out and a quantity of rock removed from the bar above the ice piers. The removal of rocks below the Pomeroy ice pier and in the vicinity was begun October 24 and continued until November 23, when high water made further work impracticable, and the boat was ordered to Ashland and discharged on November 25, 1900.

A fourth party was sent out from the snag boat on October 8, 1900, consisting of an overseer and four men, for removing snags and rocks at South Point, Ohio, opposite Catlettsburg, Ky., 315 miles below Pittsburg. Work at this place was completed on October 25, 1900.

In addition to the work done by the snag boat *Woodruff* and her crew and hired boats, the funds provided by the appropriation for operating snag boats on the Ohio River were also used by two small independent snagging parties for the benefit of low-water navigation in the neighborhood of Pittsburg and below Louisville, Ky.

On the upper part of the river a party was organized at Davis Island Dam, consisting of a quarter boat equipped with tools and explosives, in charge of an overseer with a crew of six men, which began work October 11, 1900, and was engaged principally in removing rocks from the bars at Duffs, Merriman, Deadmans Island, and the Trap, all within about 8 miles of the dam. Eight days were spent at Deadman, 1,400 rocks and about 100 feet of an old coal boat being removed from the channel. At Merriman over 600 rocks were removed. While work was in progress at Deadman a part of the crew was sent to Georgetown and Short Creek, respectively 40 and 80 miles below Pittsburg, and cleared off the bars at those points. Operations were stopped on November 21 by the rising river, but the work accomplished near Pittsburg is specially valuable on account of the narrow channel and numerous bars on this stretch of river. Details are given in the report of Mr. William Martin, assistant engineer, hereto appended.

Between Louisville, Ky., and Evansville, Ind., the navigation for packet and coal boats during September and October, 1900, was seriously endangered at several points by isolated rocks, which had been personally observed while exposed by the low water during a recent trip over this section. The Louisville and Evansville Mail Company being very desirous for their removal while conditions were favorable, tendered the services of one of their experienced pilots and otherwise assisted in preparations for the work. This party, averaging four workmen, operated from October 24 to November 19, working at Hancock Bend 13 days, at Rockport Bend 9 days, at Hog Point Bend 3 days, and at Stephensport Bend 2 days. Excellent results were accomplished, the channel and landings between Louisville and Evansville, 598 to 783 miles below Pittsburg, being completely cleared of rocks or other obstructions which could in any way interfere with navigation on this section by either low-water packets or coal tows. Details are given in the report of Mr. Newton Tebow, inspector, hereto appended.

Wrecking crews.—During the winter a number of wrecks were removed by special crews detailed from the *Woodruff* and supplied with tools and blasting outfit, the snag boat not being available for work, either on account of heavy ice at the close of the year, making travel too hazardous, or being too far away up or down the river, or being out of commission undergoing repairs. Except that mentioned at Marietta, all wrecks thus removed had been recently sunk from the descending fleets of the Monongahela River Consolidated Coal and Coke Company, and all were dangerous obstructions, whose removal was urgently desired by the owners, as well as by other coal interests.

Between December 31 and January 2 a party of three men removed a coal barge and coal boat at Collins Ripple, 143 miles below Pittsburg, which had been passed by the snag boat on her recent down trip, as the owners then had a digger taking out the coal, intending to save the boats, which were, however, found worthless and abandoned.

The party then proceeded to Marietta, Ohio, 171 miles below Pittsburg, where a coal boat owned by the Bunker Coal Company of New Orleans had been sunk on December 11, obstructing the channel so seriously as to demand immediate removal, which was authorized under emergency by the Secretary of War, pending delay in obtaining written abandonment. When the snag boat reached the wreck on her way down, the water was too low for coal-boat navigation, and the heavy ice then running made it imprudent to stop. Soon after, the owner took out the coal and broke up the boat. When examined by the wrecking party, the remains were 2 feet below the bed of the river and no work was necessary.

On April 1, 1901, telegraphic request was made by the Monongahela Coal Company, and also by the Pittsburg Coal Exchange, for the immediate removal of two coal boats recently sunk directly in the channel at Kenova, W. Va., 313.5 miles below Pittsburg. Accordingly, on April 3 a party of three men was detailed, which arrived at Kenova on the same day and made preparatory soundings. Work was begun on April 4, but a sudden rise to a height of 32 feet prevented any effect by explosives, and the work was temporarily postponed, the outfit being stored at Kenova until required.

Notice was filed by the same company on May 14 of an additional wreck at Kenova, one at Sand Island, just below Louisville, and twelve at Henderson, Ky.; all the latter being just below the bridge at that point, and causing, in addition to the bridge piers, a serious menace to towboat navigation. As these wrecks would not be reached for some time in the regular course of work, a crew of three men was again detailed from the snag boat, which first proceeded to Kenova and resumed the work begun in April, hiring extra labor as needed. The three sunken coal boats at this point (representing a loss of about $9,000) were removed on May 16. The crew then went to Sand Island, 602 miles below Pittsburg, where the wreck in the channel was similarly removed on May 20. On May 21 the party reached Henderson, Ky., 794.5 miles below Pittsburg, where the coal company had reported the sinking of six coal barges and six coal boats (loss about $30,000) by different towboats during April and May, all being in or near the channel and within about 1,000 feet below the bridge. Work was begun May 23, all obstructions found were removed, and work was completed May 27.

Details of the work by wrecking crews are given in the report of Mr. William A. Christian, assistant engineer, hereto appended.

Obstructions removed during the year by snag boat.

Obstructions removed—	Character of obstruction.				
	Snags.		Rocks.		Earth.
	Number.	Quantity.	Number.	Quantity.	
		Tons.		*Cubic feet.*	*Cubic yards.*
By snag boat during the year	613	3,419	53	3,546	....
From ice pier at Portsmouth, Ohio	....	....	....	4,829	....
By Cricket from October 1 to November 26	141	833	481	45,398	....
By Thealka from October 5 to November 25	145	65	1,240	274,158	1,000
By Levi from October 1 to November 25	30	190	1,729	93,470	....
At South Point, Ohio, October 1 to 25	163	1,024	4	1,384	....
Near Davis Island dam, October 11 to November 21	1	....	2,175	351	....
Below Louisville, October 24 to November 19	....	....	64	2,054	....

Obstructions removed—	Timber, 12 by 12—25 to 30 feet.	Loose rock.	Drift.	Wrecks.	Number of piles.	Miles traveled.
	Pieces.	*Cu. feet.*	*Cords.*			
By snag boat during the year	....	....	....	6 steamboats, 42 coal boats and barges, 3 model barges, 3 wharf boats.	....	4,404
From ice pier at Portsmouth, Ohio	38	....	....	....	....	....
By Cricket from October 1 to November 26	....	18,319	....	8 steamboats, 1 stone boat, 7 pieces coal barges.	15	988
By Thealka from October 5 to November 25	....	....	40	....	....	173
By Levi from October 1 to November 25	....	....	....	1 steamboat (partly), 1 coal barge.	....	1,002
Near Davis Island dam, October 11 to November 21.	....	....	....	1 steamboat guard, 1 coal boat.	....	....
By wrecking crews December 31 to May 27	....	....	....	10 coal boats, 8 coal barges.	....	....

Under award authorized May 18, 1901, a contract was entered into May 24 with the Chas. Hegewald Company, of New Albany, Ind., for building a stern-wheel steam launch, at a cost of $2,495, for special use in removing low-water obstructions in connection with the snag boat. Work is in progress.

While traveling over the river the snag boat has been utilized on work in connection with harbor lines and dumpage, the master of the boat making the necessary examinations and reports as to illegal encroachments, and serving notices or giving information as to the enactments on this subject.

A list of steamboat wrecks removed under this appropriation during the year, indicated by name, is hereto appended.

The operations of the snag boat have been carried on under the efficient supervision of Capt. W. H. Christian, whose report is appended.

List of steamboat wrecks, by name, removed from the Ohio River during the fiscal year ending June 30, 1901.

Name.	Location.	Miles below Pittsburg.
Percy Kelsy	Foot of Merriman	10
Comer B.	Above mouth Little Yellow Creek	47
City of New Orleans	Marietta, Ohio	172
Potomac	Below Hartford City, W. Va	245
Storm	Poage Shallows	318
Homer B	Ashland Furnace Landing	321
W. F. Nisbet	Kentucky shore above Locust Creek	429
Dick Brown	Foot of Cincinnati	469
John Fowler	Channel below Falling Run	604
Charley McDonald	Kentucky shore below Lick Run	693

LIST OF CONTRACTS IN FORCE DURING THE FISCAL YEAR ENDING JUNE 30, 1901.

Constructing one steam launch.—The Chas. Hegewald Company, May 24, 1901; approved June 8, 1901, be prepared to commence twenty days after receipt of notification of approval of contract; terminate in three months.

Summary of expenditures for operating snag boats on Ohio River for the fiscal year ending June 30, 1901.

Office expenses and superintendence	$3,841.58
Services	21,069.68
Subsistence	5,325.81
Hire of plant	2,056.00
Fuel	2,109.64
Explosives, etc	2,902.11
General supplies and expenses	1,734.45
Care and repair of plant	1,850.85
Additions to plant	2,495.00
Total	43,385.12

REPORT OF CAPT. W. H. CHRISTIAN, MASTER OF SNAG BOAT.

UNITED STATES SNAG BOAT E. A. WOODRUFF,
Portsmouth, Ohio, June 30, 1901.

MAJOR: I have the honor to submit the following report of operations of the U. S. snag boat *E. A. Woodruff* for the fiscal year ending June 30, 1901:

July 1, 1900, being Sunday, the snag boat, which had worked downstream from Pittsburg, Pa., laid over at Ironton, Ohio, 325 miles below Pittsburg, Pa. July 2 she commenced her regular work of removing snags, wrecks, rocks, and other obstructions, arriving at Cairo, Ill., July 28; 145 snags and 5 wrecks were removed. July 30 the snag boat headed upstream, reaching Pomeroy, Ohio, September 4. She removed 132 snags, 8 wrecks, and 1 rock. * * *

From September 4 to 30 the crew was employed in the removal of many large and dangerous obstructions, principally rocks, from the channel through Johnsons and Sandy shallows, between Ashland and the mouth of the Big Sandy River. The work on Johnsons and Sandy shallows was carried on from the snag boat as long as there was sufficient water to navigate her, and after she was laid up the work was carried on from two light-draft steel flatboats belonging to the snag boat. From September 4 to 30 the snag boat crew removed 251 snags, 9 wrecks, and 52 rocks from Johnsons and Sandy shallows and vicinity.

Under written proposals and acceptance, the steamboats *Cricket* and *Thealka* and gasoline boat *Levi* were hired to take the place of the snag boat *Woodruff* while she was rendered inactive by low water. From October 1 to November 27 the snag-boat crew was divided and employed on these hired boats, reports on this work being submitted separately below.

On November 27 the snag boat *Woodruff* resumed her regular work and worked downstream from Ashland, and reached Cincinnati November 28. December 4 headed upstream and reached Pittsburg December 8; left Pittsburg December 10, headed downstream, reaching Cincinnati on December 24 and worked in the Cincinnati Harbor up to the evening of the 31st.

* * * * * * *

January 9 she left Cincinnati and ran downstream to Louisville, Ky., arriving January 11. She returned to Cincinnati January 13 and was put in order for the winter. The classified employees were then furloughed without pay, and others of the crew not needed were laid off until their services should be needed for next season's work. The master, clerk, one assistant engineer, two watchmen, and a cook stayed with the snag boat to take care of the property and to attend to other necessary official business.

While the snag boat was in ordinary during the winter, drawings were made for a steel-hulled steam tender. * * * A number of smaller repairs were also provided for, and all of the above-named betterments and repairs, except the steam tender, were contracted for and the work completed.

May 1, 1901, the snag-boat crew were engaged for the working season of 1901, and on the 27th ran down to Louisville. She returned to Cincinnati on May 29, and after coaling started upstream, reaching Pittsburg June 4.

* * * * * * *

June 13 work downstream was resumed, arriving at Ironton, Ohio, June 24, and at the close of the fiscal year the snag boat was engaged on removal of ice pier at Portsmouth.

* * * * * * *

Mate McMeans, with deck hands Glaser and Donovan, was sent to remove the wreck of a coke barge at Wilsons Creek, 492 miles below Pittsburg. The removal was completed on March 8, and the men, with tools, etc., returned to the snag boat on March 9.

April 5 Assistant Engineer Christian, Mate McMeans, and Deck Hand Glaser were sent to Kenova to remove two sunken coal boats that had been reported dangerous to navigation; but before the working party arrived at the site of the wrecks heavy rains caused the river to rise rapidly and to such a height that the removal of the wrecks had to be deferred to a later date. These wrecks were finally removed on May 16 by a party of four men under Asst. Engineer William A. Christian.

Many places in the river were dragged by the snag boat without finding the obstructions reported.

Time.

Days in commission from July 1, 1900, to January 17, 1901, and from May 26 to June 30, 1901:

At work and running, including three Sundays	126
At Cincinnati, making repairs, taking stores, and awaiting orders	16
In ordinary during low water	48
Outfitting low-water boats	8
Transferring property from low-water boats to snag boat	2
Putting snag boat in order for winter	3
At Louisville, awaiting orders	1
At Pittsburg, waiting for river to fall	4
At Portsmouth, waiting for river to fall	1
Sundays, laid up	23
Holidays, laid up	5
	237
In ordinary, January 18 to April 30, 1901	103
Annual repairs, May 1 to 25, 1901	25
Total	365

REPORT OF OPERATIONS OF LOW-WATER STEAMBOAT CRICKET.

October 1, 1900, under written proposal and acceptance, the steamboat *Cricket* and barge were hired by the United States for low-water snagging and wrecking in the

Ohio River. The *Cricket* was manned by officers and men belonging to the snag boat *Woodruff*, and was supplied with necessary tools, explosives, etc., from her outfit. Capt. T. C. Davis, pilot of the snag boat, was placed in temporary command, and at 1 p. m., October 1, the *Cricket* left Ashland, Ky., ran down to Ironton, Ohio, and commenced the removal of obstructions, principally rocks, from the channel, continuing her work from Ironton upstream as far as the mouth of the Big Sandy River; returned to Ashland October 11, and on October 12 left for Conoconneque bar. Having completed work there, she left for Cincinnati. October 23 she cast off at Cincinnati and continued work until November 1, when she reached Letart Falls. Work was continued in this vicinity from November 1 to 13, inclusive. * * * She then worked downstream as far as Maysville, Ky., arriving there on the evening of November 22.

Sudden great rises in the Ohio River and tributaries put an end to the *Cricket's* useful low-water work, and she was therefore ordered to return to the snag boat at Ashland. She left Maysville on the morning of November 23 and landed alongside the snag boat about noon on November 24, when a transfer was made of the tools, explosives, etc., belonging to the United States. The transfer was completed on the 25th, and the *Cricket* and barge turned over to the owners on November 26 for return of the boats to their home port.

REPORT OF OPERATIONS OF LOW-WATER STEAMBOAT THEALKA.

October 5, 1900, under written proposal and acceptance, the steamboat *Thealka* was hired by the United States for low-water snagging and wrecking and rock removal in the Ohio River. She was manned at Ashland, Ky., partly by crew taken from the snag boat and partly by extra hired skilled and common labor. October 4 and 5 the crew was employed in transferring from the snag boat the necessary provisions, tools, explosives, etc., and in putting the boat in order for low-water work, and Mr. William A. Christian, assistant engineer, was placed in charge.

* * * * * * *

She arrived at Middleport October 7, and on the 8th work was commenced at the ice piers and continued until the 18th. October 19 the crew commenced the reduction of a long chain of high and dangerous shore rocks which extended from near the ice piers at Middleport, along the front of Pomeroy, Ohio, up to and in front of Minersville, Ohio, a distance of about 4 miles. Reduction and scatterment of this chain of rocks was continued until November 23, when a great rise in the Ohio River and tributaries stopped the work. The destruction of much valuable floating property is reported to have occurred in the past on the chain of rocks broken up and scattered between Middleport and Minersville.

November 24 the *Thealka* cast off at Pomeroy at 7 a. m. and landed alongside the snag boat at Ashland at 6.15 p. m. November 25 (Sunday) the crew completed the return of United States property, and the *Thealka* cast off and ran upstream to Catlettsburg, Ky., and was there turned over to the Big Sandy Navigation Company, her owners.

REPORT OF OPERATIONS OF LOW-WATER BOAT LEVI.

Under written proposal and acceptance, the gasoline boat *Levi* was hired by the United States for low-water snagging, wrecking, and rock removal in the Ohio River. The *Levi* left Madison, Ind., September 23, in charge of her engineer and arrived at Cincinnati September 24, when Capt. James H. Sanford was placed in charge of the boat. * * *

October 1 the *Levi* cast off on orders to proceed to the mouth of Campaign Creek, 260 miles below Pittsburg, and arrived there October 3 at 7.45 a. m. Her crew immediately commenced the reduction of the highest and most dangerons rocks on a rock bar below the mouth of the creek. At this place the Ohio shore is very flat; consequently, before removal, the rocks were not far from the middle of the river at a 10 to 12 foot stage, and were therefore dangerous, especially to descending coal tows of deep draft. Work was continued on rocks in the vicinity of Campaign Creek and Addison, Ohio, until October 22. The *Levi* then proceeded upstream to Sixmile Island; thence to Middleport, Ohio, on October 23. On the 24th she left for Short Creek. En route upstream and downstream, between October 24 and November 24, the *Levi* removed and destroyed many dangerous obstructious which had been reported by the officers of packet boats and towboats. * * *

November 24 a great rise in the Ohio River and tributaries put a stop to the low-water work of the *Levi*, and she was therefore run downstream and alongside the snag boat at Ashland to return the United States property. She cast away from the *Woodruff* at 11.45 a. m. on the 24th, and landed at Cincinnati at 11 a. m. on the 25th, when Captain Sandford turned the boat over to her owners.

REPORT OF OPERATIONS OF LOW-WATER WORK AT SOUTH POINT, OHIO.

October 1, 1900, Mr. Frank W. Phillips was employed as suboverseer, and as soon thereafter as tools, explosives, etc., could be procured for low-water work, was given charge of a working party of four men and directed to proceed to South Point, Ohio, to destroy obstructions along the Ohio side of the channel of the Ohio River, which for many years had been a menace to low-water navigation. Work at this place was begun on October 8 and continued until October 26, when a rise in the river stopped the work.

Tabular statements of the obstructions removed during the year by the snag boat, hired plants, etc., are submitted separately.

Respectfully submitted.

W. H. CHRISTIAN,
Master U. S. Snag Boat E. A. Woodruff.

Maj. WM. H. BIXBY,
Corps of Engineers, U. S. A.

REPORT OF MR. NEWTON TEBOW, INSPECTOR, ON REMOVAL OF ROCKS BETWEEN LOUISVILLE, KY., AND EVANSVILLE, IND.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, May 31, 1901.

MAJOR: I have the honor to submit the following report of rock blasting on the Ohio River between Louisville, Ky., and Evansville, Ind.:

The removal of rock which interfered with navigation was accomplished by a party averaging four good workmen, under charge of Capt. Marion Ryan, one of the best pilots on this part of the river, in the employ of the Louisville and Evansville Mail Company, who, being directly interested in this work, gave the services of Captain Ryan, assisted in securing men who were skilled in the use of dynamite, and furnished transportation for the same on their boats. Work was done at the following points:

Stephensport Bend, 695 miles below Pittsburg. * * *
Hog Point, 711 miles below Pittsburg. * * *
Hancock Bend, 715 miles below Pittsburg. * * *
Rockport Bend, 741 miles below Pittsburg. * * *

The party stopped work November 19. A total of 2,043.7 cubic yards of rocks were removed in twenty-seven days.

The above work removed all the worst rock obstructions in the way of navigation between Louisville and Evansville during low water or during coal-boat stages.

Respectfully submitted.

NEWTON TEBOW,
Inspector of Dredging.

Maj. WM. H. BIXBY,
Corps of Engineers, U. S. A.

REPORT OF MR. WILLIAM MARTIN, ASSISTANT ENGINEER, ON REMOVAL OF OBSTRUCTIONS IN OHIO RIVER.

UNITED STATES ENGINEER OFFICE,
Bellevue, Pa., June 30, 1901.

MAJOR: I have the honor to submit the following report on removing wrecks and other obstructions from the Ohio River for the fiscal year ending June 30, 1901:

* * * * * * *

October 11, 1900, a party of six men, with George W. Gibson in charge, left Davis Island Dam on a quarter boat headed downstream. This work was done chiefly for the safety of navigation during low-water periods.

* * * * * * *

November 21, 1900, the river was rising very rapidly, and as the prospect for it to recede again to allow a resumption of work was not encouraging, the work was abandoned for the season.

From Davis Island Dam to the foot of Deadmans Island, or to Big Sewickley Creek, a short distance below, there were removed about 351 cubic yards of stone, 2 snags, a part of a sunken coal boat, and part of a steamboat guard. The work is divided as to locality as follows, viz:

		Stone.
Lowries Bar	cubic yards..	5
Duffs Bar	do....	30
Head to foot of Merrimans Bar	do....	80
Channel at foot of Trap	do....	5
Shore between the Trap and Deadmans Island and Deadmans Island and Big Sewickley Creek	cubic yards..	120
Foot of Deadmans Island	do....	60
Opposite Georgetown	do....	30
Short Creek Bar	do....	21
		351

Horsetail Bar, 1 snag (large tree).

Foot of Merrimans, 50 feet steamboat guard.

Foot of Deadmans, 100 feet old coal boat and 1 snag (old stump of tree).

Respectfully submitted.

WILLIAM MARTIN, *Resident Engineer.*

Maj. WM. H. BIXBY,
Corps of Engineers, U. S. A.

REPORT OF MR. W. A. CHRISTIAN, ASSISTANT ENGINEER, ON REMOVAL OF OBSTRUCTIONS IN OHIO RIVER.

PORTSMOUTH, OHIO, *June 30, 1901.*

MAJOR: I have the honor to submit the following report on work done under my direction during the past year by wrecking crews and outfit detailed from the snag boat *Woodruff:*

On December 28, 1900, I received instructions to proceed, with three employees from the snag boat at Cincinnati, to remove coal-boat wrecks at Collins Ripple and near Marietta, Ohio. * * *

One coal boat and one coal barge wreck was found at Collins Ripple. * * * Both wrecks were found to contain a considerable quantity of coal mixed with sand. The sides, ends, several floor timbers, and parts of the bottom planks of both wrecks were broken up and floated off.

* * * * * * *

We left Marietta on the evening of January 3, bound downstream, two of the men with magazines and explosives going through to the snag boat, while I and one man stopped at Pomeroy, Ohio, to cut off the check posts on top of the Government ice piers at that point.

* * * * * * *

On April 2, 1901, I was directed to proceed from the snag boat to Catlettsburg, Ky., and Kenova, W. Va., to remove two barge wrecks at that point abandoned by the Monongahela Coal and Coke Company.

* * * * * * *

On May 16 a boatman and laborer were employed at Kenova, W. Va., and the work of removing the wrecks was commenced and completed on this day. * * *

May 17 our party left Kenova to remove a wreck at Sand Island, 602 miles below Pittsburg; work was begun and completed May 20.

* * * * * * *

On the same day we left Sand Island to remove a lot of wrecks at Henderson, Ky., 794.7 miles below Pittsburg.

* * * * * * *

Wrecks were found in and on both sides of the channel, the nearest wreck being 250 feet and the farthest about 1,000 feet below the Henderson bridge. * * *

A boatman and a laborer were employed at Henderson, and the work of removing the wrecks was commenced May 23 and completed May 27.

* * * * * * *

May 28 we rejoined the snag boat at Louisville, Ky.

Respectfully submitted.

W. A. CHRISTIAN, *Assistant Engineer.*

Maj. WM. H. BIXBY,
Corps of Engineers, U. S. A.

G G 3.

OPERATING AND CARE OF DAVIS ISLAND DAM, OHIO RIVER, NEAR PITTSBURG, PENNSYLVANIA.

Navigation through this lock and dam has been maintained continuously except for a short period while placing the new lock-gate engine mentioned below. The dam was up on July 1, 1900, was lowered twice and raised once during the year, and was up for one hundred and forty-six days.

The power house, built under contract with B. A. Groah, was completed on July 18, at a cost of $1,995.74.

Minor work of repair, etc., has included work on the hydraulic jacks of the lock, lock discharge valves in gate recesses, two new steam pumps in the new power house, changing of position of the steam boiler for the lower lock gate, and the erection of a frame building over it, erection of a new steam boiler for the upper lock gate, renovation of terreplein, lock-gate tracks, and railroad embankment slope, minor repairs to machinery, and roof of the maneuvering boat.

A small steam launch was purchased during the year for use on surveys, removal of obstructions, and for general work connected with the movable dams, and has proved very useful at this dam and the other dams.

On November 23 the dam was put down on account of high water, which continued until December 15, and as soon as the dam was down repair work was begun on the lock engines and machinery. Toward the end of December the river had fallen to a low stage, seriously interfering with the delivery and shipment of coal, and urgent requests were made by various navigation interests that the dam be put up for at least a few days. But operation of the lock was impracticable because of the repairs of engine and machinery, and the raising of the dam and control of the pool were further hampered by repairs in progress on the service bridge. By reason of the urgency of requests the dam was finally raised on the evening of January 10, but a sudden rise, with some ice and great quantities of drift, on the morning of the 11th made its immediate lowering necessary. This January raising and lowering of the dam was exceedingly risky, resulted in no apparent good, and made necessary repairs that cost over $2,000 and delayed the next raising of the dam several weeks.

The service bridge for operating the weirs of this dam, already so much deteriorated as to be extremely unsafe for workmen, sustained further injury when the dam was lowered on November 23. Its condition will not justify extensive repair and the cost of its replacement will be included in the annual estimate for operating and care for the ensuing year.

As the bear-trap dam, originally built of wood, has become badly decayed and in need of general repair, plans have been prepared for its replacement in steel, the cost of which will go into the next annual estimate.

The condition of the back-channel dam is such that it is liable to fail at any time, and provision has therefore been made for its reconstruction whenever immediate work becomes necessary. It may last without repair for another season.

Under a project approved by the Secretary of War June 18, 1900, for rebuilding the guiding cribs of this lock and an allotment of $45,000, followed later by an additional amount of $10,000, June 28, 1901, proposals were opened May 27 and June 5, and awards authorized by the Chief of Engineers, as follows:

For rebuilding 600 feet of the upper guide wall, to Robert A. Cummings, of Owensboro, Ky., at an aggregate cost of $29,215.60.

For rebuilding 230 feet of the lower guide wall, to the Evansville Contract Company, of Evansville, Ind., at an aggregate cost of $13,575.50.

For 4,000 barrels cement for the above works (to be furnished by the United States), to the Lawrence Cement Company, of Philadelphia, Pa., at an aggregate cost of $6,320.

A tabular statement of vessels passing the Davis Island Dam during the calendar year 1900, and the commercial statistics relating to the work are included with the commercial statistics of the Ohio River, p. 2624.

The work has been under the efficient supervision of Mr. William Martin, resident engineer, whose report is appended.

Operating and care of Davis Island Dam, Ohio River, near Pittsburg, Pa.

The following is a statement of the amounts and dates of all allotments for this work:

August 3, 1885	$5,865.00
July 10, 1886	12,015.00
January 28, 1887	6,700.00
July 1, 1887	12,355.00
February 25, 1888	3,500.00
July 11, 1888	18,015.00
August 20, 1889	12,073.00
May 14, 1890	2,000.00
July 17, 1890	14,752.00
October 7, 1890	14,800.00
July 10, 1891	10,338.00
July 21, 1892	11,831.48
June 27, 1893	1,300.00
July 22, 1893	12,253.82
July 18, 1894	12,459.02
May 25, 1895	450.00
July 9, 1895	$30,661.54
July 28, 1896	15,531.57
May 17, 1897	1,200.00
July 23, 1897	9,898.62
November 20, 1897	400.00
July 26, 1898	9,620.71
February 7, 1899	3,000.00
June 24, 1899	1,200.00
July 19, 1899	23,459.69
January 13, 1900	3,230.00
June 18, 1900	45,000.00
July 17, 1900	47,456.07
February 26, 1901	2,000.00
June 28, 1901	10,000.00
Total	353,365.52

LIST OF CONTRACTS IN FORCE DURING THE FISCAL YEAR ENDING JUNE 30, 1901.

Constructing brick power house at Davis Island Dam, Ohio River.—B. A. Groah, March 28, 1900; approved May 3, 1900; be prepared to commence in twenty days after receipt of notification of approval of contract; terminate July 6, 1900; extended to July 26, 1900; completed July 18, 1900.

Summary of expenditures for operating and care of Davis Island Dam, Ohio River, for the fiscal year ending June 30, 1901.

Office expenses, superintendence, etc		$1,312.55
Services		7,958.40
Fuel		464.72
General supplies and expenses		818.53
Repairs, general		1,906.32
Repairs, special		1,710.28
Total		14,170.80
Expended during fiscal year	$17,662.76	
Paid outstanding liabilities fiscal year 1900	4,357.99	
		13,304.77
Outstanding liabilities June 30, 1901		866.03
Cost of operating and care of lock and dam during fiscal year		14,170.80

REPORT OF MR. WILLIAM MARTIN, RESIDENT ENGINEER.

United States Engineer Office,
Bellevue, Pa., June 30, 1901.

Major: I have the honor to submit the following report for the operating and care of Davis Island Dam, Ohio River, for the fiscal year ending June 30, 1901.

During the early part of the year the river was very fluctuating, necessitating the lowering of the bear trap and weir No. 3 on several occasions. It then fell to a very low stage, and it became quite a difficult matter to maintain the pool on account of the rounded edges of the wickets, which could not be closed tightly by the needles. Willows and straw were freely used to stop the leakage.

The new power house, mentioned in previous report, was completed early in July, 1901.

The shafts of the lock-discharging valves in the lower gate recess, which had rigid connections with the hydraulic jacks, became more or less twisted by obstructions getting into the valves, preventing their closing. When a valve was obstructed the full power of the jack was thrown onto the shaft of the obstructed valve, which caused an injurious torsion of the shaft. Most of the valve shafts were thus twisted, making the leakage throughout the valves very great. A compensating device has been arranged, which prevents this injury. The leather packing used in the hydraulic jacks being worn out, cast-iron spring packing was substituted, which has proved more effective and satisfactory.

The corrugated-iron roof of the maneuvering boat cabin was wrecked during a gale of wind, and being unfit to repair, it was renewed with light pine boards. The sides, being of the same material as the roof, were also removed and light board siding substituted. Considerable ironwork composing the framework of the roof was also taken off and dispensed with, as superfluous weight. The boat has been considerably lightened and is much less cumbrous in handling. Two coats of paint have also been applied, and the boat is now in good working condition.

In response to a circular letter inviting proposals for a steam launch for use on the Ohio River five proposals were received, of which that of Messrs. George E. & Charles A. Painter, of Pittsburg, Pa., was accepted. The boat, with all its appurtenances, was delivered at Davis Island Dam on October 2, 1900. During the time the boat has been in service it has rendered invaluable aid in transferring boats and material from the opposite sides of the river and in the ready delivery of material from the city.

On the 23d of November the dam was lowered. The river continued high until the 10th of December, 1900, when cold weather set in and ice began to flow. As it was believed at this time that the stage of water or weather would not permit of any attempt at raising the dam again this season, the upper lock gate engine, which was badly worn out and was to be replaced by a new one, was dismantled preparatory to installing the new engine. Immediately after the old engine was removed from its foundation and the latter torn up the coal-boat interests urged to have the dam raised, which was impossible under the circumstances, or until the new engines were in operation, which were erected in place and started January 4, 1901.

During the lowering of the dam on November 23, 1900, the service bridge was damaged. The journal boxes of the 19th and 20th trestles (26 in all), counting from the abutment, were torn from their fastenings, thus rendering eight trestles of the bridge useless.

As soon as the installation of the new upper lock gate engine was complete, and at the urgent and continuous solicitation of the coal operators, preparations were made to raise the dam. The service bridge was raised to the eighteenth trestle, the nineteenth and twentieth being displaced, thus preventing the raising of the balance of the bridge, covering a length of 64 feet; this shortening of the bridge hampered the maneuvering of the dam very considerably. A portion of the pass next the bear trap, weir No. 2, and that portion of weir No. 3 covered by the 8 trestles referred to, were raised by the maneuvering boat. The entire dam was raised on the evening of the 10th of January, 1901. There had been light rains at headwaters, but no rise which indicated a stage of water at Davis Island Dam of more than 6 feet. Early in the morning of the 11th the pool began rising rapidly, with some ice and great quantities of drift; work was immediately begun to lower weir No. 3 and the bear trap, but before the lowering of the pass could be commenced the water had become so high and the accumulation of ice and drift so great that the maneuvering boat was rendered useless. A steamboat, with a barge, was sent from Pittsburg, Pa., by the Monongahela River Consolidated Coal and Coke Company, and the wickets lowered by pushing them up from the lower side. This method of lowering the dam always causes considerable damage. Examination, so far as can be made at the close of the fiscal year, shows 13 wickets, 5 horses, and 2 props broken.

Repairs to the damaged parts of the dam are in progress and nearly completed at the close of this report.

A contract was made with W. Snodgrass, of Bellevue, Pa., for building 15 new wickets, and with Thos. Carlin's Sons, of Allegheny, Pa., for building 12 new horses for repairing the Navigable Pass. These are all delivered, but it is probable they will not all be required at present. The balance will be reserved for future use.

As the steam for operating both lock-gate engines was heretofore conducted from the boiler temporarily erected at the lower end of the lock, through a pipe about 600 feet in length, the condensation of steam was very great, involving considerable waste of fuel and labor; and, believing that a more economical arrangement could be made, a new steam boiler was procured and located at the rear of the upper-gate recess. The old boiler was removed to a permanent position at the rear of the lower-gate recess, and housed with a neat frame building.

Two steam pumps, used for operating the hydraulic jacks and other purposes, have been installed in the basement of the new power house.

The original composition of Davis Island Dam was the Navigable Pass and 3 weirs, all of Chanoine wickets. The weirs were provided with a service bridge for maneuvering, while on the pass the journal boxes were put in the foundation, but the bridge was not built, it having been concluded to maneuver the latter by the service boat. In the sudden freshet occurring June 8, 1887, the service bridge of weir No. 1 was destroyed by masses of drift lodging against it, and July 9, 1899, the bridge of wier No. 2 was destroyed in the same manner. Being deprived of the service bridges of both wiers 1 and 2, the maneuvering of the dam became difficult, having only weir 3 for controlling the pool, which was insufficient to properly control the fluctuations of the river.

In the year 1888 the bear-trap chute was begun, and completed in 1889. This was built at the south end of weir No. 1, occupying 64 feet of the weir. The remainder of weir 1, 160 feet, was thrown into the pass and used as such, the pier at the junction of the pass and weir 1 being removed. The construction of the bear-trap dam aided largely in maneuvering for slight rises and in the disposition of large drift, but it and weir 3 are not sufficient to properly control the pool. To increase the weir efficiency one of two things should be done; that is, to rebuild the service bridge of weir No. 2 or construct a movable weir in the back-river dam. The former plan has the same objections as existed originally, viz, clogging with drift, which destroyed the bridge formerly; the latter is favorable for the reason that the back-river dam, which is a fixed wooden structure, is so badly decayed that its rebuilding is imperative, its failure being likely to occur at any time, its condition being past any possible economical repair, and the cost of a movable weir is about the same or less than the cost of renewing the fixed dam. To convert the back-river dam into a movable weir 4½ feet high would necessitate cutting down the old structure about 5 feet, and by the proper arrangement of abutment walls the present dam, which is 468 feet in length, would be reduced to 425 feet. This length of weir by 4½ feet high would be equal to weir 3, thus doubling the weir capacity and avoiding the necessity of renewing the service bridge of weir No. 2. A project for a movable weir in lieu of rebuilding the present timber structure has been submitted.

The bear-trap dam has now been in continuous service twelve years. The structure is built of timber and is now in such bad repair as to require entire renewal. A new design for renewal of the dam has been prepared, to be constructed of structural steel.

The operating of the Davis Island Dam has been so continuous since its inauguration in October, 1885, that no time has ever been taken for extended repairs, which are badly needed. The navigation interests have been so urgent to have the dam raised when the stage of water reached 6 feet that it has often been put up in an unfit condition, much to the detriment of the structure.

The service bridge of weir No. 3 has deteriorated to such an extent as to make its removal imperative. The sections of the members composing the bridge have been reduced fully one-half, and in its present condition it is dangerous to the workmen. The wickets of this entire weir are also in bad condition and should be renewed. This was provided for in last year's allotment, but the work was postponed for this year. The request is renewed again in this year's estimate.

On the afternoon of the 22d of June a very heavy rainfall occurred, beginning at 2.15 o'clock and continuing about two hours. The culvert underneath the Pennsylvania Company's tracks became clogged, the water from the ravine swept across the tracks and across the esplanade both above and below the lock house, carrying all manner of débris, depositing it between the lock and the railroad, and otherwise tearing up the grounds.

Plans and specifications for the reconstruction of the upper and lower guiding walls, which were referred to in the last annual report, and for which an allotment of $45,000 was made last year, were prepared. Under public advertisement of April 22, 1901, proposals were received. Those for the upper wall were opened May 27, and for the lower wall June 5, 1901. The lowest bidder for the upper wall was Robert A. Cummings, of Owensboro, Ky., and for the lower wall The Evansville Contract Company, of Evansville, Ind. Formal contracts for this work have not yet been completed.

The dam was up at the beginning of the year, lowered November 23, raised January 10, 1901, lowered January 11, and is still down at the close of the year.

Respectfully submitted.

WILLIAM MARTIN, *Resident Engineer.*

Maj. WM. H. BIXBY,
Corps of Engineers, U. S. A.

G G 4.

MOVABLE DAMS IN OHIO RIVER.

For the projects and operations relating to these works, see Annual Reports of the Chief of Engineers for 1891, page 2354; 1896, page 2100; 1897, page 2358; 1898, pages 2081 and 2082; 1899, pages 2352, 2353, and 2354; and 1900, pages 3146, 3147, and 3148.

During the past year projects for movable dams on the Ohio have been modified or extended as follows:

Dams Nos. 2, 3, 4, and 5.—A revision of the estimates of final cost of these works, based on the experience of the past five years, was made during the year, and such final cost is now estimated to be $900,000 per dam, or $3,600,000 for the four dams. These new estimates for completion were duly authorized. (See financial statements herewith.)

Dam No. 4.—A project for bank protection and dredging of a temporary channel at Logstown bar, in connection with the proposed Chanoine Dam at this site, at an estimated cost of $70,000, was approved March 29, 1901, and July 2, 1901.

Dam No. 6.—The estimated final cost of completion of this dam has been increased to $175,000, in addition to amounts already appropriated; the 1901 increase of $25,000 being due partly to the failure of the last river and harbor bill, entailing a delay of one year and thereby causing additional expense, and partly to the early arrival of the winter freshets and their long continuance in the spring of 1901. These new estimates were duly authorized. (See financial statements herewith.)

Dam No. 13.—The approved project for the lock at this site was so modified (March 15, 1901) as to permit the omission of timber facing on lock walls, use of Portland cement in entire lock walls (using stone in certain places), and lowering of lower gate sill 3 feet.

OPERATIONS DURING THE YEAR.

Dam No. 2 (about 9 miles below Pittsburg, Pa.).—The lock at this site, under contract with Eigenmann & Hollerbach and Eichel & Arnold, was completed June 14, 1900.

As the Government land at this dam had been shut off from the adjacent road by a change in the location of the latter, the purchase of the intervening strip became desirable, both in order to secure access to the public highway and also to increase the area of the tract already owned, which was too limited. The acquisition of this tract, 0.782 acre, at a cost of $1,500, was authorized.

Additional borings were completed in September, 1900, for testing foundation on the site of the proposed dam. Rock was encountered at each at reasonable depth, the overlying stratum being gravel.

Under proposals opened April 10, 1901, award was authorized to the Evansville Contract Company, of Evansville, Ind., for the construction of 500 feet length of Chanoine dam across the navigable pass, at an aggregate cost of $118,967.50, and a contract was entered into April 29, approved May 28, 1901. Work on construction of cofferdam under above contract was in progress at the end of the year.

Under proposals opened May 8, 1901, award was authorized to the Lawrence Cement Company, of Philadelphia, Pa., for 4,000 barrels Portland cement, at an aggregate cost of $5,720, for use in construction of the above dam, for which formal contract papers are being prepared.

Dam No. 3 (*about 11 miles below Pittsburg, Pa.*).—The foundations of both lock gates were finished and the recess walls almost completed; the river lock wall was completed to the top of the fifth course and the remaining three courses well advanced; the land lock wall completed to the base of the coping; the upper flushing conduit connected with the land wall and completed; excavation for the lower flushing conduit under way; the spill crib for discharge valves finished; the drift chute entrance to the upper recess built through the wall and the lower end of the chute extended 154 feet; the power conduit extended through the land wall foundation. About 72 per cent of the whole work of the existing contract has been done.

Borings were made to test character of foundation on the site of the navigable pass, rock being penetrated to a depth of from 3 to 6 feet in each case, the overlying stratum being gravel.

In order to provide increased width and depth for a temporary channel at this site, in connection with the construction of the pass, a contract was entered into with E. J. Hingston, of Buffalo, N. Y., August 3, 1900, for the removal of dikes at Whites and the Trap and for about 200,000 cubic yards dredging in the bed of the river. The removal of 950 linear feet of White's dike was completed May 18, and of 2,165 feet of the Trap dike June 18. The channel dredging is in progress.

Dam No. 4 (*about 18 miles below Pittsburg, Pa.*).—The lock at this site, under contract with Eigenmann & Hollerbach and Eichel & Arnold, was completed on January 31, 1901.

Under proposals opened June 4 for the construction of 500 feet length of Chanoine dam across the navigable pass of this dam, award was authorized to the Ætna Construction Company, of Wheeling, W. Va., at an aggregate cost of $179,572.

Under proposals opened June 6 for cement to be furnished by the United States for use in construction of the above dam, award was authorized to the Atlas Portland Cement Company, of New York, for about 7,000 barrels Portland cement, at an aggregate cost of $9,310.

Under proposals opened May 29 for the hire of one or more dredging plants to secure a temporary channel along Logstown Bar and around cofferdam of navigable pass, award was authorized to W. C. Jutte, of Pittsburg, Pa., at an aggregate cost of $22,097.50, and to H. S. Brown, of Quincy, Ill., at an aggregate cost of $21,722; each to furnish one dredge, three dump scows, and one towboat as tender.

Formal contract papers for the above awards are being prepared.

Dam No. 5 (*about 25 miles below Pittsburg, Pa.*).—The sheet piling extending from the river wall end of the lower to that of the upper gate foundation was completed; the walls of both gate recesses completed, except a small amount of coping; the land lock wall is practically completed; the river wall, including the timber facing, was completed to the bottom of the coping; the upper and lower gate track foundations completed; the upper flushing conduit completed, and the lower one built to the cofferdam, about three-fourths of its length; the drift chute is nearly completed; the upper guide wall, the spill crib, and the power conduit are completed. About 96 per cent of the whole work of the existing contract has been done.

Additional borings were made on the site of the pass to a depth of 25 feet below sill level. The stratum encountered is fine gravel with a 3-foot vein of sand in three of the holes.

Dam No. 6 (about 30 miles below Pittsburg, Pa.).—The grillage for the weirs, except the space for the pumps, was completed; the stone masonry of the pier at junction of navigable pass and weir No. 1 nearly completed; on weir 1 the concrete foundation was completed, the timber framework erected, the pedestals for gate axes of bear-trap dam set, and the structural steel work of the gates well advanced, nearly completing this weir; on weir 2 the anchor bolts were all set, the timber framework completed, the concrete built up around it, and the pedestals for gate axes set; on weir 3 (the A-frame section) the timber framework was completed and the concrete work built up to within 6 inches of the long sleepers; the concrete foundation of the abutment was built to the same height as that of weir 3, and was ready for setting the valves; the revetment crib below the abutment is well advanced; on pier 2 the foundation was built up to the culverts, the filling and discharging valves set, and the brickwork of the culverts commenced. About 80 per cent of the whole work of the existing contract has been done.

Six photographic illustrations,[1] showing the condition of the different parts of the work, accompany this report.

Dam No. 13 (about 90 miles below Pittsburg, Pa.).—The negotiations with owners and examination of abstracts of title for the various tracts of land, comprising about 17.3 acres, were completed, the deeds approved and recorded, and payments made, completing the purchase of all land now needed at this site.

Under proposals opened May 10, 1901, for constructing lock at this site, award was authorized to the Sheridan-Kirk Contract Company, of Nicholasville, Ky., at an aggregate cost of $241,805.

Under proposals opened May 16, for cement to be furnished by the United States for use in construction of the above lock, award was authorized to the Atlas Portland Cement Company, of New York, for about 16,000 barrels Portland cement, at an aggregate cost of $22,080, and to L. S. McKallip & Co., of Pittsburg, Pa., for about 23,000 barrels Cumberland and Potomac natural cement, at an aggregate cost of $20,250.

Formal contract papers for the above awards are being prepared.

A temporary office was established and preliminary work begun, the ground has been staked off, a close topographical survey made of the lock site, and a line of check levels run and bench marks established.

Dam No. 18 (about 178 miles below Pittsburg, Pa.).—In view of additional information and more exact data obtained during the progress of the survey from Marietta to mouth of Big Miami River, it was found desirable to abandon the site first selected for this work, and to locate the dam at a point below James Island and about 7 miles below Marietta. Recommendation for such change was concurred in by the Chief of Engineers and approved by the Secretary of War under date of May 24, 1901. Preparations were accordingly made for establishing an office in the vicinity in order to make local surveys and borings, arrange for the acquisition of land, and attend to other preliminary work.

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[1] Not printed.

The movable dams on the Ohio River are under the efficient supervision of Mr. William Martin, resident engineer, whose report is herewith. Mr. Martin has been ably assisted at Dams Nos. 2 and 3 by Assistant Engineer A. M. Bowman, at Nos. 4 and 13 by Assistant Engineer W. W. Venable, at No. 5 by Supt. A. B. McGrew, at No. 6 by Supt. R. W. Fulton, and at Nos. 13 and 18 by Assistant Engineer W. H. Chadbourn, jr.

Money statements.

CONSOLIDATED.

July 1, 1900, balance unexpended	$2,177,221.36
Amount appropriated by sundry civil act approved March 3, 1901	40,000.00
	2,217,221.36
June 30, 1901, amount expended during fiscal year	488,771.95
July 1, 1901, balance unexpended	1,728,449.41
July 1, 1901, outstanding liabilities	3,612.04
July 1, 1901, balance available	1,724,837.37
July 1, 1901, amount covered by uncompleted contracts	[1]399,232.33
Amount (estimated) required for completion of existing project	2,865,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	775,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

DAMS NOS. 2, 3, 4, AND 5.

July 1, 1900, balance unexpended	$1,468,475.30
June 30, 1901, amount expended during fiscal year	381,538.00
July 1, 1901, balance unexpended	1,086,937.30
July 1, 1901, outstanding liabilities	2,414.76
July 1, 1901, balance available	1,084,522.54
July 1, 1901, amount covered by uncompleted contracts	[2]350,959.02
Amount (estimated) required for completion of existing project	1,600,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	300,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

DAM NO. 6.

July 1, 1900, balance unexpended	$142,784.21
June 30, 1901, amount expended during fiscal year	82,121.31
July 1, 1901, balance unexpended	60,662.90
July 1, 1901, outstanding liabilities	675.32
July 1, 1901, balance available	59,987.58
July 1, 1901, amount covered by uncompleted contracts	48,273.31
Amount (estimated) required for completion of existing project	175,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	175,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

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[1] N. B.—In July, 1901, additional contracts for $522,556.50.

[2] N. B.—In July, 1901, additional contracts for $238,421.50.

DAMS NOS. 13 AND 18.

July 1, 1900, balance unexpended	$565, 961. 85
Amount appropriated by sundry civil act approved March 3, 1901	40, 000. 00
	605, 961. 85
June 30, 1901, amount expended during fiscal year	25, 112. 64
July 1, 1901, balance unexpended	580, 849. 21
July 1, 1901, outstanding liabilities	521. 96
July 1, 1901, balance available	580, 327. 25
July 1, 1901, amount covered by uncompleted contracts	(1)
Amount (estimated) required for completion of existing project	1, 090, 000. 00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	300, 000. 00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

The following is a statement of the amount and date of all appropriations for this work:

September 19, 1900, construction of Lock and Dam No. 6	$250, 000
July 13, 1892, construction of Lock and Dam No. 6, and purchase of land for No. 2	[2] 100, 000
August 18, 1894, construction of Lock and Dam No. 6	75, 000
March 2, 1895, construction of Lock and Dam No. 6	150, 000
June 3, 1896, construction of Lock and Dam No. 6	25, 000
June 3, 1896, construction of Locks and Dams 2, 3, 4, and 5, and purchase of land for 3, 4, and 5	[3] 30, 000
June 4, 1897, construction of Dams 2, 3, and 4	400, 000
June 4, 1897, construction of Dam No. 6	300, 000
July 1, 1898, continuing construction of Dams 2, 3, 4, and 5	595, 000
March 3, 1899, continuing construction of Dams 2, 3, 4, and 5	400, 000
March 3, 1899, construction of Dam No. 13	50, 000
March 3, 1899, construction of Dam No. 18	50, 000
June 6, 1900, continuing construction of Dams 2, 3, 4, and 5	595, 000
June 6, 1900, continuing construction of Dams 13 and 18	470, 000
March 3, 1901, continuing construction of Dams 13 and 18	40, 000
Total	3, 530, 000
June 3, 1896, authorizes contracts for complete construction of Dams 2, 3, 4, 5, and 6	2, 325, 000
June 4, 1897, modifies above in relation to Dams 2, 3, 4, and 5, and authorizes contracts for partial construction up to	2, 000, 000

LIST OF CONTRACTS IN FORCE DURING THE FISCAL YEAR ENDING JUNE 30, 1901.

Constructing chanoine dam, Dam No. 2, Ohio River.—The Evansville Contract Company, April 29, 1901; approved May 28, 1901; commence within sixty days after receipt of notification of approval of contract; terminate December 31, 1901, or as soon thereafter as the contractor shall have had one hundred and fifty fair working days, Sundays and holidays excepted, after the date fixed for commencement.

Constructing Lock No. 3, Ohio River.—Eigenmann & Hollerbach and Eichel & Arnold, December 27, 1897; approved January 21, 1898; commence as soon as practicable after approval of contract; terminate December 1, 1898; extended to December 31, 1899; extended to December 31, 1900; extended to August 31, 1901.

Removing White's and Trap dikes, and dredging near Dam No. 3, Ohio River.—Edward

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[1] N. B.—In July, 1901, contracts for $284,135.

[2] The bill provides that so much of this money as may be necessary may be used in making survey for location of Dam No. 2, and acquiring title to the land. The survey has been made and the land purchased.

[3] The bill provides that $20,000, or so much thereof as may be necessary, may be used for purchase of sites for Dams 3, 4, and 5, and, if not sufficient, so much of the moneys heretofore appropriated for Dam No. 6 as may be requisite may be used for this purpose.

J. Hingston, August 3, 1900; approved August 13, 1900; to commence in twenty days after receipt of notification of approval of contract; terminate August 18, 1901; extended to December 18, 1901.

Constructing Lock No. 4, Ohio River.—Eigenmann & Hollerbach and Eichel & Arnold, December 7, 1897; approved December 20, 1897; commence as soon as practicable after approval of contract; terminate December 1, 1898; extended to December 1, 1899; extended to October 1, 1900; extended to January 1, 1901; extended to July 1, 1901; completed January 31, 1901.

Supplemental contract for removing and replacing concrete at Lock No. 4, Ohio River, May 31, 1900; approved July 26, 1900; to commence as soon as practicable after approval of contract; terminate on or before the completion of original contract.

Constructing Lock No. 5, Ohio River.—Eigenmann & Hollerbach and Eichel & Arnold, December 27, 1897; approved, January 21, 1898; commence as soon as practicable after approval of contract; terminate December 1, 1898; extended to December 31, 1899; extended to December 31, 1900; extended to August 31, 1901.

Constructing Locks Nos. 3, 4, and 5, Ohio River, supplemental contracts.—For valve pedestal stones, March 19, 1900; approved April 9, 1900; to commence as soon as practicable after approval of contract; terminate on or before the completion of original contracts.

For special ashlar, August 24, 1900; approved September 17, 1900; terminate on or before the completion of original contracts.

For excavation and filling, October 13, 1900; approved February 13, 1901; terminate on or before the completion of original contracts.

For building weirs, piers, abutment, and portion of pass at Dam No. 6, Ohio River.—The Evansville Contract Company, May 10, 1899; approved June 5, 1899; commence work as soon as practicable after approval of contract; terminate March 10, 1901; extended to August 1, 1901.

Cement, Dam No. 6, Ohio River.—The Cummings Cement Company, September 21, 1899; approved November 28, 1899; commence delivery of cement when notified; terminate when entire quantity required is delivered.

REPORT OF MR. WILLIAM MARTIN, RESIDENT ENGINEER.

United States Engineer Office,
Bellevue, Pa., June 30, 1901.

Major: I have the honor to submit the following report on the construction of Locks Nos. 3, 4, 5, 13, and 18, and Dams Nos. 2 and 6, Ohio River; also on the removal of Whites and the Trap dikes, and dredging for temporary channel, at Dam No. 3, Ohio River, for the fiscal year ending June 30, 1901:

All the above work is now under contract except Lock No. 18; Locks Nos. 3, 4, and 5 with Messrs. Eigenmann & Hollerbach and Eichel & Arnold, and Dams Nos. 2 and 6 with the Evansville Contract Company, both of Evansville, Ind.; Lock No. 13 with the Sheridan-Kirk Contract Company of Nicholasville, Ky. (approved July 5, 1901); and the removal of the dikes and dredging with Mr. E. J. Hingston of Buffalo, N. Y. Lock No. 18 has not as yet been let.

Dam No. 2, 9 miles below Pittsburg.—As previously reported in my last annual report, Lock No. 2 was completed on the last day of May, 1900, since which time no active operations have been in progress, except 10 borings made to determine the character of the river bed along the center line of the dam. The borings vary from 10 to 26 feet in depth, rock being encountered in each case.

In the meantime plans and specifications were prepared for the building of 500 linear feet of Chanoine dam. Sealed proposals were invited, and four received and opened on April 10, 1901. The Evansville Contract Company of Evansville, Ind., being the lowest bidder, the contract was awarded them, and formally entered into April 29, and approved May 28, 1901.

The contractor had assembled his plant about May 6, preparatory to commencing operations on the construction of the cofferdam. At the close of the fiscal year the piling for guarding the cofferdam has been driven and about 220 linear feet of the cofferdam built.

Following is a statement of material expended and work done during the year:

Round piling	linear feet	4,154.5
Cofferdam	do	220

Lock No. 3, 11 miles below Pittsburg.—At the beginning of the year the work was in excellent condition for making rapid progress; the temporary plant was installed, and everything favorable for a good season's work. The work advanced rapidly and much was accomplished. Both lock-gate foundations are finished; the upper and lower recess walls about completed; the land and river walls of the lock, with the exception of the coping and some ashlar masonry, completed; excavation for the lower flushing conduit is well under way, and the spill crib for the discharge valves finished; the drift chute lacks but 10 per cent of completion, and the power conduit has been extended through the land wall. The work at the close of the fiscal year is in excellent condition and, under favorable circumstances, will rapidly be brought to a close.

The unfinished work remaining to be done consists of building the upper and lower guiding walls, finishing the drift chute and power conduit, placing the coping upon the various walls, excavating and filling for placing the hemlock floor in lock chamber, excavating the lock approaches, and filling in the esplanade.

During the last fiscal year proposals were invited for borings at this dam, but on account of high water and the lateness of the season only 6 were made. During July, 1900, new proposals were invited and the borings completed. All borings were made to rock, the maximum depth being 23 feet below the sill reference and the minimum 18 feet. The rock in each boring was penetrated to a depth of from 3 to 6 feet, the strata overlying the rock being gravel.

Following is a statement of material expended and work done during the year:

Common excavation	cubic yards..	10,537
Gravel or earth filling	do....	11,743
Stone filling	do....	500
Concrete masonry	do....	22,739
Ashlar masonry	do....	962
Special ashlar	do....	507.34
Brick masonry	do....	244
Oak timber in permanent construction	feet B. M..	192,103
Pine timber in permanent construction	do....	25,799
Hemlock timber in permanent construction	do....	116,797
Cast iron	pounds..	133,865
Wrought iron	do....	89,502
Structural steel	do....	225,038

Lock No. 4, 18 miles below Pittsburg.—This lock was completed on the 31st of January, 1901. The contractor, in accordance with section 164 of the contract, also removed from the site all rubbish, cofferdams, old and unused materials, piles, cribs, etc., and left the whole in good order and condition within the time limit of thirty days after completion of the work, as required by section 164 aforesaid.

The work of the year consisted principally in completing the land and river walls of the lock, the upper and lower gate recesses, the lower guiding wall, the spill crib for the lock-filling valves, and the power conduit and wells back of the land wall. The upper guiding wall, begun August 6, was completed during the year. The work of laying the timber floor in lock chamber was begun early in August. This floor is composed of two layers of 2-inch by 12-inch hemlock, laid transversely with the axis of the lock at a depth of 12 feet below the sill, each plank overlapping and breaking joint with the lower one, then covered with gravel to a depth of 11 feet. This work was completed in November. The work done by the contractor at this lock has been in accordance with the specifications and executed in a satisfactory manner.

Following is a statement of material expended and work done during the year:

Cofferdam	linear feet..	47
Common excavation	cubic yards..	27,177
Gravel or earth filling	do....	30,621
Stone filling	do....	469
Concrete masonry	do....	6,797
Ashlar masonry	do....	388
Brick masonry	do....	80.5
Coping masonry	do....	855.4
Valve pedestal stones	number..	32
Oak timber in permanent construction	feet B. M..	142,420
Pine timber in permanent construction	do....	27,330
Hemlock timber in permanent construction	do....	261,610
Framing timber	linear feet..	766
Bolt holes	do....	805
Cast iron	pounds..	104,380
Wrought iron	do....	74,400
Structural steel	do....	11,000

Plans and specifications for 500 linear feet of Chanoine dam of navigable pass have been prepared. Under formal advertisement dated April 27, 1901, proposals were invited, and opened June 4, 1901. The Ætna Construction Company, of Wheeling, W. Va., being the lowest bidder, the contract was awarded them. Formal contract papers are not yet completed.

Lock No. 5, 25 miles below Pittsburg.—At the beginning of the year concrete work on the gate recesses had been commenced; the track foundations built to the top reference of the track timbers, and the walls to one-fourth their height; the concrete work on land-wall foundation built up about 5 feet, making the wall continuous, though not complete, between the gate recesses; excavation for foundation of upper gate track and the sheet piling across lock chamber was finished; the upper flushing conduit, lacking 15 feet at the land wall, completed, and the excavation for the river wall foundation practically completed.

During the year, with the exception of one or two short periods, very favorable progress was made; work proceeded in a satisfactory manner, and at the close of the fiscal year the sheet piling extending from the river-wall end of the lower to that of the upper gate foundation is completed; the walls of the upper and lower gate recesses are completed; the coping on the lower gate recess wall one-third set, while the coping on the upper gate recess is completed; the land lock wall is completed with the exception of 40 linear feet of coping; on the river wall of lock the timber facing is completed, the ashlar masonry completed to the bottom of the coping, and the concrete work carried up to the height of the finished ashlar; the upper and lower gate-track foundations are completed; the upper flushing conduit is completed and the lower one built to the cofferdam, about three-fourths its total length; the drift chute lacks but 20 per cent of completion; the upper guiding wall is completed, and the excavation for the foundation of the lower guiding wall made, ready for the concrete, but has been filled up by recent floods; the spill crib along the lock-discharging valves and the power conduit are completed.

Following is a statement of material expended and work done during the year:

Common excavation	cubic yards..	21, 346
Gravel or earth filling	do....	17, 478
Stone filling	do....	475
Concrete masonry	do....	20, 575
Ashlar masonry	do....	1, 132
Special ashlar	do....	528
Brick masonry	do....	270
Coping masonry	do....	366. 2
Oak timber in permanent construction	feet B. M..	283, 565
Pine timber in permanent construction	do....	26, 100
Hemlock timber in permanent construction	do....	54, 051
Framing timber	linear feet..	760
Piling	do....	4, 662
Cast iron	pounds..	135, 281
Wrought iron	do....	109, 044
Structural steel	do....	227, 862

Ten borings, 258.5 linear feet, were made to a depth of 25 feet below sill level. The stratum encountered is fine gravel, with a 3-foot vein of sand in three of the holes.

Dam No. 6, 30 miles below Pittsburg.—At the commencement of the fiscal year work on the foundation of the weirs progressed very slowly on account of the contractor's inabilty to unwater the cofferdam inclosure embracing this work, and work on the grillage of the weirs and stone masonary of the piers advanced slowly. Not until late in August were the pumps lowered to a sufficient depth to enable the work to proceed favorably. From August until the latter part of November work progressed in a satisfactory manner, at which time permanent work was suspended on account of high water flooding the cofferdam inclosure, also causing much damage to the contractor's plant. The grillage for the weirs, except the position occupied by the pumps, is completed. On weir No. 1 the concrete foundation is completed and the framework erected, the pedestals for the axes of the bear-trap gates set, the structural steel work of the gates well advanced, and but little work remains to complete this weir. On wier No. 2 the anchor bolts are all set and the concrete built up about the timber framework, the timber framework completed, the pedestals for the axes of the bear-trap gates set, and the gates assembled in position with the exception of 3 panels or 15 linear feet. On weir No. 3 (the A-frame section) the concrete work is built to within 6 inches of the bottom of the long sleepers, the timber framework completed, the timber false floor partially completed, and 32 of the A frames erected. The pier at the junction of the navigable pass and weir No. 1 is completed except some stone paving in the culvert; the pipes for electric-light cables, air, etc., are built into the pier; the concrete foundation of the abutment built up to the same height as weir No. 3, ready for setting the valves; the revetment crib below the abutment built for a length of 120 linear feet, leaving 80 feet to be completed; the foundation of pier No. 2 is built up to the culverts, the filling and discharging valves set, and the brickwork of the culverts commenced.

Following is a statement of material expended and work done during the year:

Common excavation	cubic yards	16,424
Gravel or earth filling	do	2,680
Stone filling	do	1,716
Concrete masonry	do	7,218.3
Ashlar masonry	do	176.22
Special stone	do	109.3
Brick masonry	do	68.64
Coping masonry	do	55.99
Oak timber in permanent construction	feet B. M.	207,304
Hemlock timber in permanent construction	do	127,846
White-oak sheet piling	do	33,843
Piling	linear feet	765
Bolt holes in masonry	do	12
Galvanized-iron pipe, 1-inch	do	180
Galvanized-iron pipe, 3-inch	do	829
Galvanized-iron pipe, 4-inch	do	850
Driftbolts	pounds	8,325
Iron bolts and washers	do	39,817
Cast iron	do	22,639
Wrought iron	do	1,829
Cast steel	do	22,648
Structural steel	do	629,222

Lock No. 13, 96 miles below Pittsburg.—Proposals were invited and opened May 10, 1901, under which the Sheridan-Kirk Contract Company of Nicholasville, Ky., was the lowest bidder. Formal contract is not yet approved. The location for the lock has been staked out on the ground preparatory to beginning the construction work as soon as preparations are complete. The local United States engineer office is located within a short distance, and convenient to the site of the lock.

Lock No. 18, 173 miles below Pittsburg.—The title to the land necessary for the lock and abutment had been secured, and the plans and specifications prepared ready to invite proposals, when, for engineering reasons, the site was changed to a point below James Island, 5 miles farther downstream. A new survey will have to be made, and title to the necessary land will have to be secured before any work of construction can be done.

Removal of White's and Trap dikes and dredging temporary channel, Ohio River, 11.5 miles below Pittsburg.—This work is being done by Mr. Edward J. Hingston of Buffalo, N. Y., under contract dated August 3, 1900. Work on this contract was to have commenced within twenty days after date of notification of approval of contract, August 15, 1900, the contract having been approved by the Chief of Engineers on the 13th of said month. On account of the contractor's plant not being ready to start at this time, work was not commenced until September 14.

The timberwork on both dikes above water was first cut away and removed to the shore and burned. A temporary track was then laid along the Trap dike, and the material with which the dike was filled was carried to the shore by means of dump cars hauled by a small steam engine. This work was suspended on November 25 on account of high water. This rise, however, enabled the contractor to bring his dredge boat upon the site, and dredging began at the trap on December 3; but on account of low water work at this dike was suspended on the 12th of said month. The dredge was then taken to White's dike, and dredging begun on the 13th, but on the 14th and 15th work was again suspended on account of ice and cold weather. By this time the river had fallen to too low a stage to dump the material along the shore, and having no plant on shore to dispose of the dredged material work was again suspended until the 29th of December, at which time a cut was made through the Trap dike, about 2,050 linear feet from the lower end, to enable the dredge to get into deep water below the dike. Work was then resumed on the upper end of the Trap dike from the 1st to the 7th of January, 1901, by conveying the dredged material ashore in cars. Between the 12th and 16th of January high water interfered, but on the latter date work was again resumed by the dredge on the Trap dike and continued until the 19th, at which time work was again suspended until March, 1901, when work on this dike was resumed at intervals, there being but four days in this month in which work could be done. During April but eight days of favorable weather prevailed, during which time work was continued on the Trap dike and a good beginning made on White's dike. Work contined on White's dike until May 18, at which time the removal of 950 linear feet, the quantity required by the contract, was completed. Work on the Trap dike continued until the 24th of the month, when a break in machinery, together with high water, compelled another suspension of operations. Work was again resumed on the Trap dike in June, and pushed to completion on the 18th, there having been removed 2,165 linear feet of dike.

A beginning of the dredging for temporary channel was made on the 28th of June.

No information has been received of the occupancy of or injury to any United States pier, breakwater, lock, or dam by any individual or corporation, nor have I heard of any new bridges or structures being erected over or in the navigable waters, except under proper regulations or lawful permit.

Respectfully submitted.

WILLIAM MARTIN, *Resident Engineer.*

Maj. WM. H. BIXBY,
Corps of Engineers, U. S. A.

G G 5.

SURVEY OF LICKING RIVER, KENTUCKY.

The river and harbor act of March 3, 1899, appropriated $10,000 for survey of Licking River, Kentucky, from its mouth, opposite Cincinnati, Ohio, to Falmouth, Pendleton County, Ky., and for estimate of the cost of a lock and dam at or near Three-mile Riffle, about 3 miles from its mouth.

The final report on this survey was submitted April 17, 1900, (Appendix G G 5, Annual Report Chief of Engineers, 1900, Part V, page 3155), and was printed as House Doc. No. 645, Fifty-sixth Congress, first session.

In order to submit the final report in time for transmission to Congress it was accompanied only by small sketch maps, the large detail maps of the survey being then but partially platted. During the past year the platting of the detail maps has been continued and completed by Mr. Carl Schenk, assistant engineer, under whose efficient supervision the field work was done.

No action having been taken by Congress as to the results of the survey the completion of the maps terminates the work, the unexpended balance of the appropriation remaining undrawn in the Treasury.

Money statement.

July 1, 1900, balance unexpended	$5,576.86
June 30, 1901, amount expended during fiscal year	2,621.86
July 1, 1901, balance unexpended	2,955.00

G G 6.

EXAMINATION AND SURVEY OF THE OHIO RIVER AT MAYSVILLE, KENTUCKY.

[Printed in House Doc. No. 148, Fifty-sixth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, December 5, 1900.

SIR: I have the honor to submit herewith copies of reports, dated September 5, 1900, and November 24, 1900, by Maj. William H. Bixby, Corps of Engineers, upon preliminary examination and survey, respectively, authorized by the emergency river and harbor act approved

June 6, 1900, of the Ohio River in the vicinity of Maysville, Ky., with a view to the construction of a pier for a harbor of refuge on the south shore of the river at or near that place.

Major Bixby states that Maysville is already an excellent natural harbor at low water, lacking only protection against running ice, and that in his opinion the construction by the General Government of an ice harbor there is justified by the commercial interests involved. The cost of the improvement proposed by him is estimated at $21,000.

The views and recommendations of the local officer are concurred in by the division engineer, Col. Henry M. Robert, Corps of Engineers.

Very respectfully, your obedient servant,

John M. Wilson,
Brig. Gen., Chief of Engineers,
U. S. Army.

Hon. Elihu Root,
Secretary of War.

PRELIMINARY EXAMINATION OF OHIO RIVER WITH A VIEW TO THE CONSTRUCTION OF A PIER FOR A HARBOR OF REFUGE ON THE SOUTH SHORE AT OR NEAR MAYSVILLE, KENTUCKY.

United States Engineer Office,
Cincinnati, Ohio, September 5, 1900.

General: I have the honor to submit herewith a report upon a preliminary examination of the Ohio River at or near Maysville, Ky., with a view to the construction of a pier for a harbor of refuge on the south shore of the river at that place, as required by the act of Congress approved June 6, 1900, as well as by instructions of letter from your office under date of June 13, 1900.

The field work of this preliminary examination was made, under my direction, by Assistant Engineer R. R. Jones on July 30 and 31, 1900, and his report, including a sketch map,[1] is hereto appended.

Maysville, county seat of Mason County, Ky., is situated on the south shore of the Ohio River, about 405 miles below Pittsburg, Pa., and only about 61 miles above Cincinnati, Ohio. It lies approximately midway between Cincinnati, Ohio, and Portsmouth, Ohio.

The place was first settled in 1784, and soon became an important distributing center. The city was incorporated in 1833. It has now a population of about 9,000, with extensive manufacturing interests, and is a market for a large and fertile agricultural region.

Maysville is entered by two important railroads, and is a regular stopping point for all packets between Cincinnati and points on the Upper Ohio, 1,030 landings having been made by such packets at the public wharf during the year 1899. In addition to these the landings for purely local business (steam ferry) numbered about 8,000. The city lies on the concave side of a gentle bend of the river, a little below where the channel crosses over from the north to the south shore. A pool of rather deep water extends past the city front, and the thread of the channel through this pool opposite the public wharf lies from 200 to 300 feet from the Kentucky shore at ordinary boating stages.

The river tonnage passing Maysville in 1899 was estimated at

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[1] Not printed.

6,400,000 tons, with a total value of about $12,800,000. It is obviously difficult to determine the exact proportion of the tonnage which would be benefited by the construction of an ice harbor at this point, but a conservative estimate places it at from 300,000 to 400,000 tons, with a value of from $600,000 to $800,000.

Cincinnati, Ohio, affords a reasonably good ice harbor by reason of ice piers owned by private parties and the piers of the bridges which span the Ohio River. The next harbor upstream possessing adequate protection against running ice is 113 miles above, at Portsmouth, Ohio, where the Government has constructed an ice pier of four cribs. Between these there is, to be sure, a small ice harbor at Ripley, Ohio, where the Government has constructed an ice pier of two cribs; but the protected space at Ripley is quite small, and all of the harbor below the cribs is shoal and inaccessible at low stages of the river. Descending tows occupy not less than sixteen hours in making the run from Portsmouth, Ohio, to Cincinnati, Ohio, and the ascending tows, consisting mostly of empty barges, consume about thirty hours in the passage between the same points. The construction of an ice harbor of adequate size at some point nearly midway between Cincinnati and Portsmouth would greatly diminish the risks now incurred by river craft by reducing about one-half the time required in making the passage from one safe harbor to another.

Maysville is an excellent natural harbor at low-water stages, lacking only protection against running ice. The deep water extends from about the mouth of Limestone Creek, some 800 feet above the public wharf, downstream for nearly one-half mile along the city front. A small bar which has formed at the mouth of Limestone Creek even now serves to slightly deflect the current, and an ice pier, consisting of three or four cribs, located at this point would probably serve to protect the city frontage for a length of from one-fourth to one-half mile downstream from the creek.

The steamboatmen appear to desire the construction of an ice pier at Maysville, and the coal shippers of the Kanawha and Monongahela rivers, as well as the regular packets and other steamboats plying between Cincinnati and upriver points, would all undoubtedly benefit from such constructions. The mayor and leading citizens of Maysville greatly desire to have their natural harbor protected from running ice, and the owners of riparian rights will relinquish such rights so far as concerns the necessary use of the piers and harbor frontage during ice flow.

In view, therefore, of the amount of river traffic which would be benefited by the construction of an ice harbor at Maysville, Ky., and in view also of the excellent facilities which the present natural harbor at that place offers for such constructions, I have the honor to recommend favorably the construction of a pier for a harbor of refuge on the south shore of the Ohio River at or near the city of Maysville, Ky., and to report that the Ohio River at this point is worthy of such improvement by the General Government.

The information already on hand in this office, obtained from past surveys and reports upon this section of the Ohio River, will greatly reduce the cost of the necessary surveys and reports. It is estimated, therefore, that the cost of such necessary surveys, including plan and estimates of cost and other reports, will be about $100. The available funds from unexpended balances for the Ohio River general improvement are sufficient to cover the above estimated cost of survey, so that no special allotments appear necessary therefor from the special appropriation of the act of June 6, 1900.

Very respectfully, your obedient servant,

Wm. H. Bixby,
Major, Corps of Engineers.

Brig. Gen. John M. Wilson,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. Engineer Office, Southwest Division,
New York, September 7, 1900.

Respectfully forwarded to the Chief of Engineers, United States Army.

I concur with Major Bixby in the opinion that the Ohio River at or near Maysville, Ky., is worthy of improvement by the General Government to the extent of the construction of a pier on the south shore for a harbor of refuge.

Henry M. Robert,
Colonel, Corps of Engineers,
Division Engineer.

[Second indorsement.]

Office Chief of Engineers,
U. S. Army,
September 12, 1900.

Respectfully submitted to the Secretary of War.

This is a report upon preliminary examination of Ohio River with a view to the construction of a pier for a harbor of refuge on the south shore at or near the city of Maysville, Ky. The examination was made to comply with provisions of the emergency river and harbor act approved June 6, 1900.

It is the opinion of the local officer, concurred in by the division engineer, Col. H. M. Robert, Corps of Engineers, that in view of the river traffic which would be benefited by the construction of an ice harbor at this locality, and in view also of the excellent facilities which the present natural harbor at Maysville offers for such constructions, the improvement is worthy to be made by the General Government.

I recommend that survey of the locality and preparation of plan and estimate of cost of improvement contemplated be authorized, the expense, estimated at $100, to be paid from the appropriation for Ohio River, general improvement.

John M. Wilson,
Brig. Gen., Chief of Engineers,
U. S. Army.

[Third indorsement.]

War Department,
September 12, 1900.

Approved as recommended by the Chief of Engineers.

G. D. Meiklejohn,
Acting Secretary of War.

REPORT OF MR. R. R. JONES, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, September 1, 1900.

MAJOR: I have the honor to submit the following report upon a preliminary examination of the Ohio River at and near the city of Maysville, Ky., with a view to the construction of a pier for a harbor of refuge on the south shore of the river at that place, as required by the act of Congress approved June 6, 1900, and by your letter of instructions to me under date of June 23, 1900.

The field work of this preliminary examination was made by me July 30 and 31, 1900.

Maysville, Mason County, Ky., is situated on the south shore of the Ohio River, about 405 miles below Pittsburg and 61 miles above Cincinnati, Ohio. It lies approximately half way between Cincinnati, Ohio, and Portsmouth, Ohio.

The first settlement was made at this place in 1784, under the name of "Limestone," when a blockhouse was erected on the river bank, on what is now Front street, between Market and Limestone streets. Mason County was organized in 1788, prior, in fact, to the admission of Kentucky as a State. Limestone (Maysville) was established as a town by the legislature of Virginia in 1787, but in 1793 the name was changed to Maysville. As early as 1785 the settlement was a distributing center for the interior of the State via Lexington, to which point a road had been opened. The city was incorporated in 1833, and in 1848 it became the county seat of Mason County.

The present population of Maysville is estimated at about 9,000. There are four banks, with an aggregate capital of $335,000 and annual deposits of about $1,500,000. The city has extensive manufactures, including tobacco, plows, saddlery, brick, furniture, machine works, flouring and sawmills, and 4 distilleries. It is also an important market for tobacco, corn, wheat, and garden products. The city is entered by the Chesapeake and Ohio and Louisville and Nashville railroads.

Maysville is the terminal point of one steamboat packet line, is connected with the town of Aberdeen, Ohio, by steam ferry, and is a regular stopping point for all packets plying between Cincinnati and upper Ohio points. In 1899 there were 1,030 landings made by the steamboats at the public wharf, besides about 8,000 landings for purely local business (ferry). The city lies along a slightly concave shore, opposite a long pool of rather deep water, and just below a crossing of the channel from the Ohio to the Kentucky shore. Limestone Creek debouches into the Ohio River about 800 feet above the public landing. Immediately below Limestone Creek is a small bar, caused by material (sand, gravel, and small stone) which has been carried out by the creek. Just below this bar is situated a coal incline and landing. At the public wharf a wharf boat is moored, and between the wharf boat and coal incline is the landing of the ferryboat which plies between Maysville and the town of Aberdeen, on the Ohio shore. Above the mouth of Limestone Creek the water is shoal, and therefore not well adapted for the location of an ice harbor. From the mouth of Limestone Creek downstream good water extends past the city front for nearly half a mile, and near the lower end of this frontage a second coal landing is located.

There are probably few locations where an ice pier would afford greater advantages than Maysville as a refuge against running ice, as it would be accessible at even very low stages of the river.

Observations were made of the direction taken by floating objects passing the public wharf at Maysville, the stage of the river being about 11½ feet. The main current of the river, after crossing from the Ohio shore toward the Kentucky shore, appears to follow nearly parallel to the south, or Kentucky, shore, and about 200 feet distant therefrom, from the mouth of Limestone Creek to a point one-half mile or more below, whence it trends toward the middle of the river. The small bar at the mouth of Limestone Creek appears to deflect the current of the river even at the stage mentioned, and at or near low water it probably exerts a much greater effect. It is believed that an ice pier located near the mouth of Limestone Creek would operate to deflect the running ice to such an extent that the public wharf and river front of Maysville would be protected for a length of from one-fourth to one-half mile.

Interviews with the mayor and leading citizens of Maysville, including members of the improvement committee, indicate a strong desire to have the present natural harbor protected from running ice by the construction of an ice pier. The steamboat men who could be interviewed desire to have such pier constructed. The owners of the land opposite and just below the probable site of a pier signify a willingness to relinquish their riparian rights, so far as the use of the harbor adjoining the piers during the time of running ice is concerned.

The annual river tonnage (coal and general merchandise) passing Maysville is estimated at 6,400,000 tons.

On account of the varying conditions which prevail during the late fall, winter, and early spring months, when the bulk of this tonnage is moved, it is difficult to arrive at a precise estimate of the percentage of such total tonnage as might under certain conditions be affected by the construction of an ice harbor at or near Maysville, Ky.

During a comparative open winter the ice frequently runs at intervals, leaving the river open at intervening periods. Such conditions tempt the coal shippers to send out loaded tows to the down-river markets, and to bring back the empty barges—the latter running from one safe harbor to another as opportunity offers. The ascending tows of empty barges naturally take the greater risk in their endeavor to make home ports on the Kanawha and Monongahela rivers before navigation is entirely closed by the next run of ice.

A rough approximation of the annual tonnage likely to be affected by the construction of an ice harbor at Maysville, Ky., would be 350,000 tons, with a value of about $700,000. At the present time there is no ice harbor suitable for tows of any considerable size between Cincinnati, Ohio, and Portsmouth, Ohio, a distance of about 113 miles. At the latter point there is an ice pier of four cribs. The time usually occupied in making the run between the points named is, for loaded tows descending the river, from sixteen to twenty hours; and for ascending tows with empty barges, from thirty to thirty-six hours. For regular packets or other steamers unincumbered with tows the time occupied in making the passage is of course much less.

If a safe ice harbor of adequate size were to be provided at some point about midway between Cincinnati and Portsmouth, the risk of accident to floating craft would be diminished about one-half, as, instead of from thirty to thirty-six hours being consumed by a tow in making the upward run from Cincinnati to the next harbor above, only about fifteen or eighteen hours would be required.

The ice pier at Ripley, Ohio (two cribs), 8 miles below Maysville, Ky., affords neither adequate protection as regards size nor safe approach during low stages of the river, as the water below the pier is shallow.

Maysville, on the other hand, is a natural low-water harbor, having a good depth of water, but no protection against running ice.

In view, therefore, of the amount of river traffic passing Maysville, Ky., the natural adaptability of the locality as an ice harbor, and the greatly increased protection which such a harbor would afford river interests, I have the honor to favorably recommend the locality of Maysville, Ky., for the construction of an ice pier to consist of at least three cribs. A survey sufficient to determine the precise location of the pier, together with plan and estimates of cost, and other reports, is estimated to cost only about $100, the greater part of the information being already on hand in the shape of past surveys and reports upon this part of the Ohio River.

Very respectfully, your obedient servant,

R. R. Jones,
Assistant Engineer.

Maj. Wm. H. Bixby,
Corps of Engineers, U. S. A.

SURVEY OF OHIO RIVER WITH A VIEW TO THE CONSTRUCTION OF A PIER FOR A HARBOR OF REFUGE ON THE SOUTH SHORE AT MAYSVILLE, KENTUCKY.

United States Engineer Office,
Cincinnati, Ohio, November 24, 1900.

General: I have the honor to submit herewith a report upon a survey of the Ohio River at or near Maysville, Ky., with the view to the construction of a pier for a harbor of refuge on the south shore of the river at that place, as required by the act of Congress approved June 6, 1900, as well as by instructions of letters from your office under date of June 13 and September 15, 1900.

The field work of this survey was made under my direction by Assistant Engineer R. R. Jones. A reduced map[1] of the locality, showing the location of the proposed ice piers, is herewith inclosed;

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[1] Not printed.

this map being the same as accompanied the report on preliminary examination, and the original tracing being already in your office.

Maysville, county seat of Mason County, Ky., is situated on the south shore of the Ohio River about 405 miles below Pittsburg, Pa., and only 61 miles above Cincinnati, Ohio. It lies approximately midway between Cincinnati, Ohio, and Portsmouth, Ohio. The city has at present a population estimated at about 9,000. Maysville is entered by two important railways, and is a regular stopping place for all packets between Cincinnati and points on the Upper Ohio, 1,030 landings having been made by such packets at the public wharf during the year 1899. In addition to these, the landings for purely local business numbered in 1899 about 8,000. The river tonnage passing Maysville annually is now estimated at 6,400,000 tons, with a total value of about $12,800,000.

There is no good ice harbor in the Ohio River at present between Portsmouth and Cincinnati, a distance of 113 miles. Maysville is already an excellent natural harbor at low-water stages, lacking only protection against running ice. An ice pier consisting of three cribs, located just below the mouth of Limestone Creek, would probably serve to protect the city frontage for a length of from one-fourth to one-half mile downstream from the creek, and would be of great use to the general river traffic, as well as to the local navigation interests of the city of Maysville. In my opinion, an ice harbor at Maysville is worthy of construction by the General Government.

Artificial ice harbors on the Ohio River have in the past been formed by the construction of from 2 to 4 stone-filled timber cribs placed in the river near the shore which it is desired to protect from running ice, the entire combination of such cribs being termed an ice pier. Each crib is about 17 feet wide and 20 feet long on top, with three sides almost vertical, and the fourth side, the one facing upstream, being given a slope of about 6 feet vertically to 5 feet horizontally. The cribs are usually placed about 20 feet apart measured across the river, and about 12 feet apart measured up and down the river, the crib nearest the shore being placed farthest upstream. The cribs are given heights of from 30 to 40 feet above low water, the outer pier being lowest and the pier next the shore being highest. An ice pier built in this way of 2, 3, or 4 cribs forms altogether a half-open pier, with a sloping upper face which catches the ice, breaks it, and forms it into an ice gorge extending obliquely from the shore to the outer crib, by which subsequent ice is deflected toward the center of the river in such way as to leave a comparatively clear open harbor for water craft below the ice-pier cribs.

The value of such ice piers as a protection from running ice in the Ohio River has been aptly demonstrated in past years at the points, such as Middleport and Gallipolis, where such ice piers have been constructed, either by private parties or by the United States Government. In order to be of special value, however, such piers should be so located as to protect an already existing good natural depth of water below them, or the place below must be specially dredged.

Ice piers of stone-filled timber cribs, built and located in the manner above described, give excellent results, but have been found to rot out to such an extent in twelve or fifteen years as to either need entire replacement or to need repair at a cost almost as great as that of a new pier. When first used in the Ohio River such piers cost only about $2,500 per crib. A few years later the cost amounted to about $3,500 per crib, the increased cost being due to the advance in prices of timber, stone, and labor, especially that of good timber. To-day similar cribs are estimated to cost $6,000 per crib, or $18,000 per ice pier of 3 cribs. Owing to the perishable nature of timber, it is now advisable to substitute concrete and iron for timber and iron as far as possible, especially as concrete piers can be built to-day at a cost very little in excess of those of timber.

An ice pier composed of three small separate piers with concrete walls, tied together with iron rods and filled with stone or loose gravel, the whole resting on a crib and concrete foundation expected to be so solid as to last forty or fifty years or more without any considerable repair, is estimated to cost $21,000 if built at Maysville in the location shown on the accompanying map.

Such a construction is considered as justified by the commerce involved, and an appropriation for that amount by the General Government for such construction is herewith recommended.

Very respectfully, your obedient servant,

Wm. H. Bixby,
Major, Corps of Engineers.

Brig. Gen. John M. Wilson,
Chief of Engineers U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. Engineer Office, Southwest Division,
New York, November 27, 1900.

Respectfully forwarded to the Chief of Engineers, United States Army.

I concur in the opinion of Major Bixby that the interests of commerce justify the construction of an ice pier at Maysville, Ky., consisting of three detached piers, and also in his recommendation that they be built of concrete and iron, at an estimated cost of $21,000.

Henry M. Robert,
Colonel, Corps of Engineers,
Division Engineer.

APPENDIX H H.

IMPROVEMENT OF HARBOR AT PITTSBURG, PENNSYLVANIA, OF ALLEGHENY RIVER, PENNSYLVANIA, AND OF MONONGAHELA RIVER, WEST VIRGINIA AND PENNSYLVANIA.

REPORT OF MAJ. CHAS. F. POWELL, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1901, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Monongahela River, West Virginia.
2. Monongahela River, Pennsylvania.
3. Operating and care of locks and dams Nos. 1 to 9, Monongahela River.
4. Harbor of Pittsburg, Pennsylvania.
5. Construction of locks and dams at Herr Island, above the head of Sixmile Island, and at Springdale, Allegheny River.
6. Allegheny River, Pennsylvania.

HARBOR LINES.

7. Ohio River at Allegheny City, Pennsylvania.

Engineer Office, United States Army,
Pittsburg, Pa., July 19, 1901.

General: I have the honor to transmit herewith annual reports of works under my charge for the year ending June 30, 1901.

Very respectfully, your obedient servant,

Chas. F. Powell,
Major, Corps of Engineers.

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. A.

H H 1.

IMPROVEMENT OF MONONGAHELA RIVER, WEST VIRGINIA.

The building of four locks and dams and completing two locks and dams, comprising this improvement, were readvertised for bids in the early part of the year, and a contract awarded for all the works. The contractor entered upon the site at No. 11 and began active operations. The contract, however, proving a failure, the works were again readvertised, and then for a fourth time, and new contracts executed for Nos. 10, 11, 12, and 13.

Three awards in succession were made for Nos. 14 and 15, and contract entered into on the third award for these locks and dams with The

T. A. Gillespie Company, of Pittsburg, at prices pertaining to the first award. This contract has been approved since the end of the year.

Lock and Dam No. 10.—Small hired-labor operations and job work let under competition, begun here near end of previous year upon annulment of contract, were continued on account of failure of subsequent contract and defective or exposed condition of parts of the work. Two top courses of unfinished upper guard crib, showing fungi and decay, were replaced with sound timbers and the crib built six courses higher and ballasted. Bad filling of lower guard and land cribs was removed to near pool level, open spaces between timbers closed with stone and the ballast properly replaced, and for the land crib brought to full height, top paved, and snubbing post dressed to shape. The lock cofferdam was repaired. Its lower leg had to be rebuilt, and was laid diagonally downstream to inclose a considerable section of bank where flood volumes pouring through the open lock and the gap at middle of dam had done much damage and threatened more. The contract land crib having moved bodily a few inches, the filling behind it was taken out and suitable material properly placed instead, and concrete footing blocks laid in small trenches cut in the ledge rock against outer ends of bottom crib ties. The upper end of face of crib was beveled to better join with the lock-chamber face. An extension of this crib having bottom timbers bolted to the rock 12 feet width, height of 2 feet above pool and 103½ feet length was built, and the lower part of the slope of the bank paved for 40 feet downstream therefrom. The bank next above the lock and wing wall having been badly cut, a 12-foot protection and guide crib 30 feet long was built there to part height, anchored by bolts and concrete stops to the rock base, and good filling put behind and the top bank riprapped. Old pieces of contractor's plant left in the lock chamber and filling culverts, together with much waste, débris, and deposit, projections of the rock bottom above proper level and all loose or partly loose rock were removed. Depressions in the surface of the rock, which is disposed in thin layers and apt to be disrupted, were concreted to the general level. Timber cushions at sills of lower level, oak hollow quoins at the adjacent gates, and temporary filling of middle-gate recesses left for future use when forming the concrete, were placed to pool level. In general, necessary low-level work was done while the cofferdam was useful to avoid maintaining the coffer and another pumping out of the lock. Filling valve frames, the valves and operating parts, timber cushions at upper sills, and 20 snubbing pins on lock walls were also set, and several defective places in the lock walls and dam, generally at the facing, repaired by cutting out the unsound mortar or concrete and making good refilling.

The grounds were grubbed and cleared, stumps and drift along the bank burned or removed, and form boards left at lock walls taken off. Grading of the lock grounds was completed. In connection with it a rubble masonry head wall founded on rock was built across the mouth of a deep ravine, back and next upstream from the lock, and a 30-inch sewer pipe about 200 feet long laid from the wall to the river for carrying storm water. The meandering deep ditch across the lock land cut by waters from the ravine was filled; also, a rubble masonry retaining wall 370 feet long, a 60-foot section of which is 8 feet high above the lower ground and of 8 feet base and other portions 6 feet high and 5 feet base, all with ample weepers, was constructed against the foot of the steep hillside near positions for lock dwellings and opposite the lock; basement walls for the dwellings built, drainage pipes laid, and bank slopes and lock terreplein partly paved.

At the abutment of the dam a 4-foot concrete core wall running well into the bank was made, the grading of abutment slope nearly completed, and the slope paved to near flood line for a length of 158 feet. The paving foots against a low concrete wall founded in the rock.

The whole amount of excavation done during the year is 24,140 cubic yards; embankment, 14,680 cubic yards; masonry wall laid, 450 cubic yards, and paving laid, 965 square yards.

Lock and Dam No. 11.—The new contractor began preparations on the ground for work only near end of the year, the execution of contract papers having been delayed and the season generally unfavorable for river work.

Locks and Dams Nos. 12 and 13.—The contractor here started operations promptly at No. 12, but met with interruptions by river rises. A cofferdam at the lock space, temporary trestle across the river for transporting machinery from the railroad to the lock side, a cement house and other buildings were built, and erection of cableway across the river begun. The lock site was grubbed and cleared and 1,150 cubic yards of material excavated and 500 yards put in embankment.

It is proposed to apply the available balance and appropriation recommended on existing contracts, contract for building Locks and Dams 14 and 15, and for remaining lock and gate irons and accessory works not covered by contracts named, at Nos. 10 and 11, or 12, according to progress on their main structures.

Money statement.

July 1, 1900, balance unexpended	$688,084.27
June 30, 1901, amount expended during fiscal year	45,296.74
July 1, 1901, balance unexpended	642,787.53
July 1, 1901, outstanding liabilities	20,124.75
July 1, 1901, balance available	622,662.78
July 1, 1901, amount covered by uncompleted contracts	494,561.78
Amount (estimated) required for completion of existing project	350,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	250,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

June 10, 1872, improving Monongahela River between Morgantown and New Geneva	$25,000
March 3, 1873, improving Upper Monongahela River, near Morgantown, W. Va	66,000
June 23, 1874, improving Upper Monongahela River, near Morgantown, W. Va	25,000
March 3, 1875, improving Upper Monongahela River, near Morgantown, W. Va	22,000
June 18, 1878, improving Monongahela River, West Virginia and Pennsylvania	25,000
March 3, 1879, improving Monongahela River, West Virginia and Pennsylvania	24,000
June 14, 1880, improving Monongahela River, West Virginia	25,000
March 3, 1881, improving Monongahela River, Pennsylvania and West Virginia	25,000
August 2, 1882, improving Monongahela River, West Virginia	25,000
July 5, 1884, improving Monongahela River, West Virginia	45,000

August 5, 1886, improving Monongahela River, Pennsylvania and West Virginia	$90,900
August 11, 1888, improving Monongahela River, West Virginia	35,000
September 25, 1889 (allotment)	4,000
July 13, 1892, improving Monongahela River, West Virginia	25,000
August 18, 1894, improving Monongahela River, West Virginia and Pennsylvania	20,000
June 3, 1896, improving Upper Monongahela River, West Virginia	30,000
June 4, 1897, improving Upper Monongahela River, West Virginia	350,000
July 1, 1898, improving Upper Monongahela River, West Virginia	400,000
Total	1,261,900

Contracts in force.

No.	Name of contractor.	Character of work.	Date of—		
			Approval.	Beginning work.	Expiration.
1	The T. A. Gillespie Co.	Building locks and dams 12 and 13 on Monongahela River above Morgantown.	May 3, 1901	May 24, 1901	May 24, 1903
2	Baker & Judson, Gloversville, N. Y.	Completing locks and dams 10 and 11 on Monongahela River above Morgantown.	June 3, 1901	June 26, 1901	June 26, 1903

No.	Name of contractor.	Rates.												
		Grubbing and clearing (lump bid).	Earth excavation, per cubic yard.	Hardpan excavation, per cubic yard.	Rock excavation, per cubic yard.	Embankment, per cubic yard.	Concrete, per cubic yard.	Stone ballast in cribs, per cubic yard.	Stone paving, per square yard.	Timber for gates, spars, quoins, and sills, per M feet B. M.	Timber for cribs, Class A, per M feet B. M.	Timber for cribs, Class B, per M feet B. M.	Bolts, drift, per pound.	Bolts, screw, per pound.
1	The T. A. Gillespie Co.	$500	$0.40	$1.00	$1.50	$0.30	$8.10	$2.00	$2.25	$88.00	$50.00	$50.00	$0.04	$0.04
2	Baker & Judson, Gloversville, N. Y.	200	.50	1.25	3.00	.30	7.25	2.00	2.50	80.00	30.00	60.00	.05	.05

COMMERCIAL STATISTICS.

Two lines of daily packets run from Pittsburg to Morgantown, and two towboats do jobbing in pools 8 and 9, belonging to the slackwater system of the river in West Virginia. Such boats would probably run in the new pools, besides those which may be engaged in expected coal traffic there.

Comparative traffic passed through United States locks Nos. 8 and 9.

Year.	Lock No. 8.		Lock No. 9.	
	Passengers.	Freight.	Passengers.	Freight.
Calendar year:	*Number.*	*Tons.* [a]	*Number.*	*Tons.* [a]
1892	18,663	20,770	17,932	20,644
1893	24,534	17,587	23,932	19,427
1894	18,610	24,329	16,968	17,134
1895	15,107	19,826	11,459	10,759
1896	11,006	31,722	11,296	13,735
Fiscal year:				
1898	29,124	64,138	26,428	33,543
1899	27,156	73,837	25,310	41,503
1900	23,794	72,317	21,609	57,211
1901	18,886	39,545	15,523	32,486

[a] 2,000 pounds.

H H 2.

IMPROVEMENT OF MONONGAHELA RIVER, PENNSYLVANIA.

The act of March 3, 1899, provided for enlargement and improvement of Lock No. 6, extension of fender and mooring crib 300 feet and building deflecting dike at Lock No. 3, and for additional pieces of floating plant. The dams named are part of the extensive slack-water system acquired by the United States in 1897.

Extensive work at the lift wall and other parts near head of Lock 6 had been done in the previous year. The remaining enlargement and improvement of the lock was accomplished late last fall and winter, except that the concrete superstructure of new upper-guard wall was not built; its heavy timber foundations were laid and temporary fender for boats erected on its top, the river having been too high all the spring and early summer for advantageously laying the lower courses of the concrete top. The lock walls were extended at their lower ends; new lower miter sill built 6 feet farther downstream than the old sill and lowered 1.5 feet; guard sill of same elevation added; lower gates rebuilt and hung in oak hollow quoins and upper ends of former gate recesses filled. Penstock section of flume and outlet for turbine were built in the masonry on land side. A concrete guide wall, 114½ feet long, was constructed below and in prolongation of land-chamber wall; rock bottom at lower entrance was excavated within limits of cofferdam to give 1 foot greater depth than on the sills, and dredging done along the low-water line downstream from cofferdam and at site of new upper-guard wall. The old crib on outside of river wall, put there to help sustain the weak wall, was removed; a good new crib built to pool surface; space between crib and wall concreted and the concrete, 1½ to 2 feet thick, carried against back of wall to top, all voids, and bad jointing previously picked out, being refilled at time of the backing. The rock bottom of lock chamber was deepened; fire-clay seams under long sections of the walls cut out and filled with mortar, and these places faced with concrete; also voids in face of river wall where the stones had been forced back several inches and even more. About 600 square yards of faces of walls were dressed to vertical planes, bad jointing picked out and properly replaced. The walls were then thoroughly grouted. All work upstream from lower end of old lock walls was done by the hired labor repair crews.

Operations were prosecuted under much difficulty and with some delay from cold weather and freshets, but done at the season of least traffic. While the lock was closed to navigation a transfer incline over the dam for accommodation of traffic was maintained when practicable; at other times and when packets ran, transfers were made by land.

At Lock No. 3 the deflecting dike was completed, also substantially the fender crib extension. This was intended for first construction to be a concrete wall resting on pile foundation, built in the river along low-water line. The owner of abutting property would not permit material to be taken across his unoccupied lands from the adjacent railroad, neither his land to be occupied by working plant, even with rental, until the land was purchased at an excessive price. On the other hand delays had ensued by negotiation, and it was not deemed advisable to occupy at the time the lock entrance with protections, forms, and floating plant for concrete work. So the work was made for present use of pile construction, long piles being used and stoutly braced, and then faced with 5-inch oak plank and decked, and with the expectation that when the pile tops decay or weaken the piles will be cut off below low water, timber platform laid, and masonry wall erected.

It is proposed to apply the available balance at Lock and Dam No. 6, in completion of upper guard wall; enlarging the dam, improving its abutment, and at improvement work at lock machinery, grounds, and buildings, and for authorized floating plant.

The following extract from report by Assistant Engineer T. P. Roberts gives quantities and further details of the work:

> Before any work could be done by the contractor it was necessary to close the numerous large leaks through the river wall of the lock, for without doing this the cofferdam, designed to include the lock chamber and a considerable area of river bed below the lock, could not have been pumped out. Owing to important work undertaken at Lock No. 7 the repair crew was not able to start work at No. 6 until late in September, and progress was retarded by the unexpected necessity of repairing a section of the dam next to the lock wall and in dredging out obstructions which would have prevented steamers reaching the freight transfer.
>
> The work of dredging the foundations to the rock bottom for the extension of the guide wall below the lock involved the removal of numerous tree trunks and slabs from sawmills, etc., which were found to be solidly embedded in the river bank. It was found necessary to continue this shore dredging of rubbish mixed with the clay and sand overlying the rock for several hundred feet downstream to obtain sufficient depth for loaded coal vessels. By November 21 the cofferdam was completed, but a rise on the 26th stopped work, and it was not until December 11 that work could be fairly started in blasting out the foundations for the new guide wall.
>
> The land-wall extension, including the penstock, adds about 14½ feet to the length of the wall. The new guide wall, as built from the end of the extension of land wall, measures 114½ feet, making a total length of 129 feet. The guide wall proper is reached by several steps down from the lock wall; its base width is 10.9 feet, top 5 feet, and average height from bed rock 23 feet. In making the connections with the old wall it was found necessary to remove from 4 to 5 feet of the old wall to secure a good bond. The river wall, as finally repaired and extended, is 8 feet longer than before. In the construction of the extension of lock walls, guide wall, and penstock below the lock, 1,445.5 cubic yards of concrete were laid. In the excavation for foundations for these walls and in deepening the channel approach to the lock within the area inclosed by the cofferdam (excepting the lock chamber where the rock was removed by United States employees) the contractor moved 495 cubic yards of earth and 660 cubic yards of solid rock. Owing to the irregular, seamy nature of the rock and its softness in places after exposure to the freezing weather, considerably more excavation was rendered necessary in securing foundations than was anticipated, and for the same reasons an increase in the amount of concrete work became necessary. Work on these walls was successfully prosecuted by the contractor regardless of the temperature, which at times reached several degrees below zero, by keeping the work under cover and resorting to heating by lines of steam pipe and stoves and by warming the ingredients of the concrete.
>
> By the middle of March the contractor had completed his work below the lock, and on the 25th the cofferdam was removed. Owing to high water continuing almost uninterruptedly until the end of June, the contractor was unable to start on the concrete guard wall above the lock, the timber foundations of which had been placed during the winter by the repair crew.
>
> The work of the repair crew during the winter and spring was scarcely less important than that done by the contractor and required much ingenuity in shutting off leaks, choking down "springs" issuing from the bedrock, underpinning the lock walls with concrete in extreme cold weather, where resort was had to primitive but nevertheless very efficacious methods of working mortar and concrete under the most trying conditions.

The amount, $12,500, estimated as authorized by Department letter, of funds for 1902 is here repeated. The reasons for the estimate appear on page 3230 of the annual report for 1900.

Commercial statistics are given with the report upon operating and care of locks and dams, Monongahela River.

Money statement.

July 1, 1900, balance unexpended	[1]$175,627.67
June 30, 1901, amount expended during fiscal year	73,307.45
July 1, 1901, balance unexpended	102,320.22
July 1, 1901, outstanding liabilities	6,710.57
July 1, 1901, balance available	95,609.65
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901 Submitted in compliance with requirements of sundry civil act of June 4, 1897.	12,500.00

APPROPRIATIONS.

August 11, 1888, costs of condemnation, Lock and Dam No. 7, Monongahela River, Pennsylvania	[2]$5,000.00
September 19, 1890, costs of condemnation, Lock and Dam No. 6, Monongahela River, Pennsylvania	[3]5,000.00
August 11, 1888, purchase of Upper Lock and Dam (No. 7), Monongahela River	[4]161,733.13
September 19, 1890, purchase of Upper Lock and Dam (No. 6), Monongahela River	[3]162,000.00
June 3, 1896, cost of condemnation property of Monongahela Navigation Company	5,000.00
June 3, 1896, award for property of Monongahela Navigation Company	3,761,615.46
March 3, 1899, improving Locks 3 and 6 and for floating plant	50,000.00
June 6, 1900, completing improvement at Locks 3 and 6 and for floating plant	135,556.00
Total	4,285,904.59
Amount carried to surplus fund	328,431.77
	3,957,472.82

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[1] The unexpended balance July 1, 1900, reported in annual report for 1900, should have been less by expenditures made from appropriation for "Costs of condemnation property of Monongahela Navigation Company," not previously reported, viz:

January 27, 1900, Treasury settlement 9630	$200.00
June 6, 1900, Postal Telegraph Cable Company, telegram	.20
Total	200.20

[2] Partly applied—$98.64 to surplus fund.

[3] To surplus fund.

[4] Partly applied—$161,333.33 to surplus fund.

H H 3.

OPERATING AND CARE OF LOCKS AND DAMS, MONONGAHELA RIVER, WEST VIRGINIA AND PENNSYLVANIA.

The slack-water system afforded by these works comprises nine dams, at the first four of which, counting from mouth of the river, are double locks.

Monthly lockages of vessels at different dams.

	Dam.								
	1.	2.	3.	4.	5.	6.	7.	8.	9.
1900.									
July	2,010	1,712	1,200	1,116	278	251	193	245	166
August	1,355	1,365	1,226	1,167	263	234	187	189	161
September	1,218	1,184	1,037	893	252	244	157	203	156
October	1,129	1,308	1,333	1,148	292	262	191	182	160
November	1,118	1,040	1,348	807	256	115	154	157	139
December	2,065	1,980	1,485	1,326	321	125	138	154	135
1901.									
January	2,130	1,707	1,483	1,254	356	120	119	123	123
February	603	607	707	652	158	11	9	8	6
March	2,104	1,806	1,516	1,299	223	49	52	63	56
April	2,027	1,811	1,336	1,221	273	107	103	107	40
May	2,067	2,071	1,577	1,406	434	249	182	183	131
June	1,866	1,853	1,519	1,342	400	281	184	194	198
Total	19,692	18,444	15,767	13,631	3,506	2,048	1,619	1,808	1,471

The locks were temporarily closed to navigation for times and reasons as follows:

Locks.	Repairs.	Floods.	Ice.	Total time.	Number of times.
No. 1:	*d. h.*	*d. h. m.*	*d. h.*	*d. h. m.*	
Large		4 20 20		4 20 20	3
Small		4 20 20		4 20 20	3
No. 2:					
Large		5 19 50		5 19 50	3
Small		5 19 50		5 19 50	3
No. 3:					
Large		5 19 0		5 19 0	3
Small		5 19 0		5 19 0	3
No. 4:					
Large		3 4 0		3 4 0	2
Small		10 16 30		10 16 30	4
No. 5	3 0	4 6 45		7 6 45	5
No. 6	*a*153 0	2 2 0		155 2 0	3
No. 7	50 0	8 2 5		58 2 5	6
No. 8		1 5 30	2 0	3 5 30	2
No. 9	26 0	6 7 55	5 0	37 7 55	7

a Lock closed for enlargement and improvement. See report Monongahela River, Pennsylvania.

From the end of July to the last week in November dry weather prevailed, marked by lower water in the middle and upper pools than has been experienced on the Monongahela for many years. From September 10 to October 20, pool No. 3, owing to excessive evaporation and leakage at the dam and lock gates, remained below the level of the crest of the dam, and for seven days of this period there was less than 4 feet depth on the lower sill at Lock No. 4. The freshet near end of November overflowed the locks at the lower end of the river to the depth of nearly 9 feet on the walls, but did little damage.

January and February were cold and much ice formed, rendering navigation very difficult at times. From the first week in March to the end of June there was a remarkable succession of moderate freshets, keeping the river at a depth, without the aid of flashboards on dams, sufficient for boats drawing 8 feet. The same favorable conditions for river coal trade obtained during the spring and early summer on the Upper Ohio, so that the great accumulation of loaded coal craft at Pittsburg harbor from the Monongahela was shipped to down-river ports.

The following were the principal repairs made to structures and works done for the maintenance of the channel:

Locks and Dam No. 1, Pittsburg.—Basement walls and floors of lock dwellings, which are frequently flooded, were repaired; 403 square feet of concrete floor were laid in the basement of lock-master's house, and sewer drop repaired. The first story of the river front of lock-tender's dwelling, where the bricks were crumbling, was faced with concrete and pointed, and the plumbing work mentioned in last year's report completed. A low retaining wall paralleling the lock walls part way below the boiler house, about 196 feet long, was built to support the bank and make more room for storage purposes. At two points concrete steps were placed, leading up from the terreplein to the storage grounds about the warehouse. At the best, the facilities for storing cement, machinery, timber, and other supplies received at Pittsburg for use at various points up the river is much cramped. The second floor of the warehouse was fitted up for the storage of ropes and small articles and with shelving for care of numerous patterns belonging to the Government. The water wheel operating the river wall gates was extensively repaired and furnished with new gear wheels and bronze bearings. Five carloads of heavy oak plank for renewal of the sheeting of the upper slope of dam and several carloads of oak and hemlock were received and stored for the repairs of upper guide and guard cribs, and materials purchased for extensively repairing the lower guide crib. Several hundred feet of 2-inch and 3-inch oak plank were used in the renewal of the bumping plank on the lock gates. Faces of cribs exposed to the abrasion of passing vessels were lubricated from time to time with heavy petroleum, not only at this lock but at other locks along the river. No doubt this expedient prolongs the life of the timbers and keeps a smoother surface. Flashboards were maintained on the dam during the summer and until November. With their aid a depth of 8 feet or over was maintained in pool No. 1, notwithstanding the severity of the drought from July to October.

Locks and Dam No. 2, Port Perry.—One hundred and ninety-seven feet 3¼-inch shafting with bearings were placed on the temporary land wall of large lock for operation of gates, of which 90 feet were new and 107 feet old shafting which had been used before the disruption of the old wall, described in last year's report; 673 tons of derrick stone under contract were placed below the dam outside the river wall, where a scour of about 30 feet depth threatened the stability of the lock wall. About 400 feet B. M. oak plank were used in repairs of lock gates. A new clutch coupling was placed on main line shaft on land wall; 500 feet B. M. oak plank used in repairs of crib at head of middle wall; 6,750 square feet of channel face of cribs lubricated with heavy oil. In July the passenger steamer *J. G. Blaine* collided with one of the lower gates of the small lock and broke one of the anchorages. A duplicate iron was on hand and repairs were made without serious detention to the use of the lock. During August it was necessary to calk the flashboards on the dam with straw to maintain desired pool depth. Four new buckets were placed in the water wheel at the dam. A freshet in November, overflowing the lock walls to the depth of 8.3 feet, left a deposit of drift in the large lock which required some time for its removal. Several carloads of heavy oak plank were received and stored for repair of upper slope of the dam. Up to the end of June the water remained too high and muddy for a careful examination of the dams, but it is not thought that any of them was seriously damaged by ice or spring floods. Material was purchased for rebuilding the upper guide crib. The friction gearing on the middle wall was dismantled and generally overhauled.

Locks and Dam No. 3, above Elizabeth.—It was mentioned in previous report that heavy riprap stone was being placed in a deep hole below the abutment of the dam. During the summer and fall examination disclosed other points along the dam and outside the river wall of the lock which required similar protection. In all, between July and October, 1,466 tons of stone were deposited under contract below the dam and near the lock wall. The old shore guide crib, 489 feet long above the lock, which was much decayed, was faced between October and March with new pile work strongly braced, decked, and sheeted throughout its length. In all there were used in this new work 294 white-oak piles, 52,000 feet B. M. oak plank, and 10,600 pounds spikes, drift, and screw bolts. For about 100 feet from the lock wall there was room for only one row of piles, but gradually, as the line of the old crib receded from the lock-wall line prolonged, room was afforded for two, three, and finally four rows of piles. The piles were driven generally to a depth of about 15 feet and placed 4 feet, center to center, along the river face and sawed off at the level of the top of the lock walls. The channel face of the new work was sheeted with 5-inch and decked with 3-inch oak plank. Specially braced piles at about 50-foot intervals were left for snubbing posts for checking tows. The turbine water wheel on the land wall was taken out and sent to a machine shop for extensive repairs. New screens were placed in the flumes and land-wall shaft bearings rebabbitted. Thirty-five feet of the worst section of the upper sheeting of the dam were replaced by new work in the fall. New suspension fork and bolt were placed in lower inside gate small lock; a new gate spar sheave set at upper end of small lock and several of the chain sheaves about the locks, which were worn out, replaced with new ones. About 500 feet B. M. oak were used in repairs to lock gates. The spring floods caused a very extensive deposit below the locks, threatening to stop navigation about the middle of May. With 8 feet on the lock sill, boats drawing only 2 feet could enter the small lock. A dredge boat operating an orange-peel bucket from a revolving turret, with a boom nearly 60 feet long, was secured to remove the deposit. This was for the most part coal in small pieces, which had evidently been long in the river, as shown by the rounded forms of the particles, ranging in size from a half inch to 2 inches or more in diameter. Of this deposit the dredge boat, between May 15 and June 21, removed 11,600 yards and placed it behind the guide crib or on the shore below, of which quantity nearly 4,000 cubic yards had to be moved twice. Fully three-quarters of the material dredged was coal, as above described. This influx of coal waste from the third pool is difficult to account for, there being no mines in active operation on the lock side of the river for several miles above the dam. A number of years ago it was the custom of operators at most of the mines to dump their so-called "coal dust" into deep holes in the river, and bars of such material, in which much merchantable coal could be found, were occasionally formed in the river. The high floods and heavy ice drift of the past winter may have transported this material to and over the dam, whence it was carried by eddy current to near lock entrance.

Locks and Dam No. 4, below Charleroi.—Work in overhauling the walls of the small lock was completed in July. In addition to the repairs noted in previous report, several leaks through and beneath the foundation timbers were detected and closed with cement grout. During the fall the upper guard crib was renewed with a pile-work facing, the new work extending in prolongation of the lock-chamber face a length of 166 feet. There were used in this work 137 piles 31 to 38 feet long, about 24,000 feet B. M. oak timber and plank, and about 4,500 pounds of bolts and spikes. Upstream from the pile work 6 clusters of piles averaging 19 each were driven on a line convex to the channel with spaces of about 25 feet between clusters. The turbine on the middle wall was repaired and new bronze bearings placed on its shaft supports. About 1,350 feet B. M. oak plank were used in repairs of lock gates. A platform on the lower end of the river wall, carried away by the November flood, was rebuilt; 190 feet linear of oak guard rail were placed on the lock coping to prevent snubbing lines from cutting or wearing on the masonry. Several of the friction drums of the lock gate machinery were turned to make better contact. The upper gates of the small lock were thrown for repairs, and four of the old wickets in them replaced with new ones. In May work was started in the rebuilding of the shore guide crib below the lock. The old crib, which was 320 feet long, was much decayed and beyond further repair, and as it curved toward the river more than desirable it was removed entirely. Rises in the river interrupted operations and caused slips of the bank to come in, but at the end of June 162 feet of the lower portion had been put together and sunk in one section with its top showing above lower pool level. The bottom of the trench excavated for the crib is 4 feet below the elevation of the lower sill of large lock. The width at base of the crib is 15 feet, which will diminish to 10 feet at the finished top, or about 10 feet above lower pool level; 250 cubic yards of stone ballast had been placed in the crib at the end of June.

Lock and Dam No. 5, above Brownsville.—Important repairs to the lower end of the river wall in progress, as described in previous report, were completed early in July, the cofferdam at the lower end of the chamber removed, and the lock thrown open to navigation. The lockmaster's dwelling, which was subject to being flooded occasionally, was raised 4 feet, and extensive repairs made to the lower floors, sides, roof, and other parts. The old frame office building, which had become unworthy of repairs, was removed bodily about 50 feet to higher ground in the rear, and a new frame building, 20 by 14 feet, erected in its place. The old building is used temporarily as a store shed. A low crib on the upper slope of the dam, built many years ago to strengthen the timber abutment of the dam, which was badly damaged by drift during the spring floods, was repaired at the expenditure of about 5,300 feet oak timber and plank and 329 pounds of bolts and spikes. Stone for filling the crib was obtained from a bar in the river below the dam.

Lock and Dam No. 7, below Greensboro.—The repair crew, with repair boats, built and hung all four new lock gates, repaired guide cribs above lock, repaired and grouted masonry of lock walls, tore down high abutment wall at end of the dam to about 2½ feet above crest of dam, relaid coping of lowered abutment wall, rebuilt top of abutment crib downstream from the wall and constructed foundation for and partly built guide wall below land wall of lock. This guide wall being 84 feet long, 16½ feet high above foundation, and having an average thickness of 9 feet, contains about 460 cubic yards of masonary above the foundation. The river face is sheeted with 4-inch oak plank. Dam No. 7 is nearly 100 feet shorter than the dam next below, and 75 feet shorter than the dam next above it. The effect of this contraction has been to create violent countercurrents below the lock where the navigation at the best is hampered by the rough, rocky ledges projecting from the river bank, and upon which a number of steamers have been injured, while rafts have frequently been detained many hours in the eddy. On the opposite side of the river, below the abutment of the dam, which presented a vertical face of masonry nearly 20 feet above crest of the dam, the river bank was caved to such an extent as to threaten the flanking of the abutment and its ultimate destruction. With the expectation of partly reducing the reaction of flood currents the face of the abutment was sloped, thereby also increasing the discharging area over the dam. In dismantling the old lock gates of a discarded construction it was found that the oak arms below water were sound, and that they could be advantageously used for foundation of a short guide wall below the lock. Upon these heavy timbers, which were securely bolted to the rock, the large dimension stones taken from the abutment of the dam and first used to weigh down a bulkhead when lock was being pumped out, were utilized in the construction of a substantial guide wall 84 feet long, which has materially diminished danger and delay attending the passage of vessels through the lock at critical stages of navigation. A retaining wall back of the terreplein of the lock was built in two sections. The section downstream from the lockmaster's dwelling has an average length of 50 feet with 25 feet return wall at the lower end, or a total of 75 feet in length, 6 feet thick at base, 3 feet thick on top; average height, 13½ feet. The section upstream from the dwelling is 196 feet long, same thickness and height as the downstream section, and contains about 420 cubic yards of masonry including stone steps about opposite upper gates. For full completion of the last-mentioned section about 20 cubic yards of masonry are yet to be laid. The abutment bank was cut back to slope of about 2 on 1. The excavation amounted to about 4,000 cubic yards of earth. The slope was protected with riprap paving, abutting against abutment crib and masonry, and extending up the slope for an average distance of 28 feet or to elevation about 5 feet higher than the lock walls, and extending also from crest of dam 110 feet downstream and 56 feet upstream. The abutment slope protection was farther extended by means of loose riprap to 186 feet upstream from crest of dam and to 181 feet downstream from crest of dam and to top of high bank, the slope measurement of which is about 30 feet;

average depth of the bank protection is 18 inches, except that a large basin-shaped hole back of abutment crib was filled with stone to depth of several feet. Extension of the riprap downstream was in progress at the close of the year. Other minor works were: Construction of low wall across terreplein to height of and opposite upper gates and containing about 6 cubic yards; construction of dry masonry footing wall from lower end of guide wall to foot of bank, 30 cubic yards; reconstruction of oil house, 9 by 9 feet; lowering repair shop, and excavation of basement for second dwelling.

Lock and Dam No. 8, mouth of Dunkard Creek.—The paneling of all four lock gates was renewed. Riprap protection of right bank above lock was removed, the slope cut back 1 on 2 by excavation of about 1,200 cubic yards of earth, and the riprap protection partly replaced. Repair of masonry of lock walls was commenced. All disintegrating portions of coping on both walls, 300 square yards, were cut away to depth of 2 to 3 inches and depressions filled with cement mortar. Minor repairs were made to abutment masonry and abutment slope protection.

Lock and Dam No. 9, Hoard, W. Va.—The terrace slope at terreplein was cut back parallel with the lock and on slope of about 1 on 2.25, and excavated material, about 375 cubic yards, together with about 400 cubic yards sand and loam wheeled from the beach below the lock, was used in filling the depressed terreplein back of lock. The riprap paving was replaced on the filled terreplein. The lower part of the regraded terrace slope was paved and the upper part sodded. In this work 1,130 square yards of paving and 21½ square rods of sod were placed. The terrace slope stone steps at lower end of lock were moved upstream and placed about opposite office on grade to conform to slope. Riprap protection on left bank was extended from abutment downstream for a distance of 925 feet; average width of slope protected, 34 feet; average thickness of riprap, 18 inches, with footing in ditch 3 by 3 feet. Riprap protection on right bank below lock was made 522 feet long by 30 feet wide; average depth, 18 inches, and footing ditch 3 by 3 feet. The masonry wing of abutment was lowered to conform with the natural slope of the bank, and the stone used for heavy riprap on the upstream side of the abutment wall. On April 15, while a steamer was being locked and the chamber about half full, one of the lower gates unexpectedly rode over the sill, dragging the other gate with it and totally wrecking both. Owing to high water, the repair steamer *Slackwater* was unable to reach the place until the 17th. Both gates were taken down and jacked up on the river beach, where it was found that 9 new arms would be required and that many of the irons would have to be welded and straightened. Repairs were completed and the lock opened for use on May 10. New spars were made for the lower gates and rigged with wire rope instead of manila rope, as formerly used. Cut gear wheels were put in hand gear for operating Stoney valve. The rear porch of the locktender's dwelling was repaired and inclosed for use as a kitchen and outside steps of dwellings repaired.

Boat yard and shop, Lock No. 4.—The corrugated roof and sides of the timber shed were painted. Owing to the necessity of using the yard force upon important works of repair at locks 4, 6, 7, and 9 and emergency calls for their services at locks 3 and 5, the completion of the sawmill and machine shop was unavoidably delayed. The frame of the sawmill was erected, the contractor for corrugated roofing material experiencing great trouble in obtaining the sheets from the mills; the launchway for lock gates was extensively overhauled; a number of the flatboats in use for transporting timber, gravel, sand, etc., were calked and otherwise repaired; a board walk 245 feet long was laid on street paralleling the timber shed; a large amount of material was received and transferred from the railway station to the grounds and shipped as needed to various locks. In order to afford more room for rafts and boats at the landing or harbor opposite the grounds, 5 clusters of piles, at right angles from the shore, numbering 104 piles in all, were driven several hundred feet above the old protection cribs, which were about to give way. The openings between new pile clusters are about 16 feet. The old breaker cribs were being removed at the end of June. In previous report it was stated that the repair force was engaged "in the construction of 8 lock gates." It should have been added that only 4 gates were completed. The record of lock-gate construction at the boat yard under the United States is—

1898, 3 gates completed, 4 partly made; 1899, 7 gates completed, 1 partly made; 1900, 4 partly completed, 4 partly made; 1901, 4 gates completed, 6 partly made; making 18 gates built and 6 partly made.

Dredging.—During the year dredging under contract was done at lock entrances or pool channels as follows:

	Cubic yards.
August, 1900. Third pool, along shore below Lock No. 4, gravel and bowlders	4,500
December, 1900. Third pool, along shore below Lock No. 4, gravel and bowlders	1,485
January, 1901. Third pool, along shore below Lock No. 4, gravel and bowlders	2,125
May, 1901. Third pool, removed 320 feet of old shore guide crib below Lock No. 4, crib material, stone, sand, clay, and gravel	6,000
June, 1901. Third pool, material slipped from bank at old crib below Lock No. 4, earth and sand	2,575
May and June, 1901. Second pool, below outlets of locks at Dam No. 3, coal waste, sand, and gravel	15,538
Total	32,223

Snagging.—There were removed from the channel in the various pools the following snags or stumps: Pool 1, 12; Pool 2, 2; Pool 3, 29; Pool 4, 8; Pool 5, 2; Pool 6, 8; Pool 7, 10; Pool 8, 54; Pool 9, 104.

Removal of obstructive wrecks, broken down and abandoned coal tipples and cribs.—Pool 1, old hull of steamboat *Traveler;* Pool 2, 6 protection cribs; Pool 3, 1 loaded coal-boat wreck, 15 tipple piers and protection cribs, 1 wreck of empty coal boat, and 1 wreck of coal barge.

Plans of the following-named bridge and other structures over or in the river above the Youghiogheny River were approved and permits granted therefor:

Bridge.

Date of permit.	To whom issued.	Locality.
June 18, 1901	Glassport Bridge Co	Port Vue Borough.

Coal tipples, protection cribs, etc.

Date of permit.	To whom issued.	Kind of structure.	Locality.
1900.			
July 27	A. R. Budd Coal Co	Fill and coal tipple	Near N. Webster, Pa.
Oct. 6	Union Steel Co., Pittsburg	Protection cribs, intake, and coal-hoist piers.	Webster, Pa.
Nov. 1	The Marine Coal Co	Coal tipple and protection cribs.	Fayette City, Pa.
Nov. 14	Jas. Neale	do	New Frederickstown, Pa.
1901.			
Jan. 4	C. Jutte & Co., Pittsburg	Rebuilding old protection cribs.	Pool 2.
Jan. 17	Flint & Co., Pittsburg	Coal tipple and protection cribs.	Pool 3, 4 miles below Lock No. 4.
Jan. 28	Riverview Coal and Coke Co	Coal tipple	Head of pool 6.
Mar. 9	Peoples Coal Co., Pittsburg	Coal tipple and protection cribs.	Brownsville, Pa.

Telephone and other electric wires.

Date of permit.	To whom issued.	Kind of structure.	Locality.
1900.			
Aug. 13	Federal Telephone Co	Telephone cable	Belle Vernon, Pa.
Aug. 31	Farmers Telephone Co	Telephone wires	Pools 8 and 9.
Oct. 11	Federal Telephone Co	do	Pool 4.
Nov. 14	do	do	Pool 3, Courtney-Elkhorn.
Nov. 28	Monongahela Valley Electric Co.	Electric-light wires	Pool 5.
1901.			
Feb. 13	Federal Telephone Co	Telephone wires	Brownsville, Pa.

Pipe lines.

Date of permit.	To whom issued.	Kind of structure.	Locality.
1900.			
Aug. 17	American Window Glass Co	Gas main	Monongahela City, Pa.
Oct. 23	Greensboro Natural Gas Co	do	West Brownville, Pa.
Nov. 9	Crescent Pipe Line Co	Change of oil pipe	Oliver Station, Pa.

Miscellaneous.

Date of permit.	To whom issued.	Kind of structure.	Locality.
1900.			
Oct. 23	American Ax and Tool Co	Intake pipe	Glassport, Pa.
1901.			
Jan. 19	American Steel Hoop Co	Part of pumping station	Monessen, Pa.
Jan. 22	G. W. Weigle & Co., Dravosburg, Pa.	Lumber storage platform and boat yard.	Roscoe, Pa.
Jan. 26	McKeesport Sawmill Co	Sawmill and log way	¼ mile above mouth of Youghiogheny River.

Money statement.

July 1, 1900, balance unexpended	$119,216.13
Amount allotted for fiscal year 1901	175,474.96
	294,691.09
June 30, 1901, amount expended during fiscal year	159,496.37
July 1, 1901, balance unexpended	135,194.72
July 1, 1901, outstanding liabilities	34,574.18
July 1, 1901, balance available	100,620.54

ALLOTMENTS OF FUNDS.

August 15, 1884	$1,000.00	July 8, 1891	$24,250.00
September 1, 1884	4,000.00	July 21, 1892	34,017.86
November 3, 1884	4,500.00	July 21, 1893	23,574.72
December 20, 1884	500.00	July 23, 1894	25,664.00
June 1, 1885	100.00	July 12, 1895	20,372.40
July 22, 1885	1,000.00	July 28, 1896	19,232.84
July 10, 1886	1,200.00	July 15, 1897	[1]13,070.87
March 1, 1887	1,100.00	August 2, 1897	[2]119,734.49
July 1, 1887	11,000.00	October 8, 1897	125.00
July 11, 1888	6,270.00	September 1, 1898	[3]197,627.93
October 27, 1888	3,000.00	August 14, 1899	169,838.00
July 17, 1889	1,480.00	September 7, 1900	175,474.96
October 7, 1889	1,500.00		
November 6, 1889	1,200.00	Total	873,133.07
July 24, 1890	12,300.00		

Classified statement of expenditures incurred in operating and care of Monongahela River locks and dams during fiscal year ending June 30, 1901.

Item.	Amount.
Services	$84,763.55
Supplies	15,337.57
Materials	40,184.69
Repair plant	8,867.02
Dredging, snagging, etc	8,293.82
Office and travel expense, freight, telephone, and telegraph	2,049.72
Total	159,496.37

COMMERCIAL STATISTICS.

Two lines of packets, comprising five steamers, made daily trips between Pittsburg and Morgantown; a packet makes week-day round trips between Pittsburg and Monongahela City, second pool; two packets ran from Charleroi, fourth pool, one to Lock No. 6, and the other to McLane's landing, sixth pool; and a small steamer plies between Webster and North Charleroi, third pool. Several large excursion boats ran during summer between Pittsburg and points in the lower pools. New river coal mines were opened in the fourth, fifth, and sixth pools.

Lockages made and traffic passed at Monongahela River locks during year ending June 30, 1901.

At dams—	Lockages.		Steamboats.		Coal boats, barges, flats, and boat bottoms.		Rafts.	
	Up.	Down.	Up.	Down.	Up.	Down.	Up.	Down.
	Number.	*Number.*	*Number.*	*Number.*	*Number.*	*Number.*	*Number.*	*Number.*
1	10,098	9,594	7,254	7,220	12,723	12,734	489	29
2	9,434	9,010	5,892	5,875	15,182	15,249	397	37
3	7,918	7,849	4,869	4,850	16,407	16,376	148	67
4	6,895	6,736	4,120	4,139	14,188	14,287	131	74
5	1,696	1,810	1,412	1,414	873	853	4	115
6	989	1,059	842	838	310	321	2	86
7	770	849	710	710	174	175	1	102
8	860	948	719	718	157	163	3	104
9	721	750	677	676	164	158	....	45
Aggregate	39,381	38,605	26,495	26,440	60,178	60,316	1,175	659

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[1] Locks 8 and 9.

[2] Locks 1 to 7, inclusive.

[3] Locks 1 to 9, inclusive.

Lockages made and traffic passed at Monongahela River locks during year ending June 30, 1901—Continued.

At dams—	Other craft.		Coal.		Coke.		Rails, steel.	
	Up.	Down.	Up.	Down.	Up.	Down.	Up.	Down.
	Number.	*Number.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Tons.*	*Tons.*
1	552	526	191,200	108,674,500	....	316,000	223	72,384
2	338	340	58,000	143,821,868	....	....	3,373	3,440
3	180	172	22,500	148,802,000	....	....	285	60
4	180	165	17,300	124,132,500	....	....	332	42
5	282	275	23,700	4,026,250	....	....	110	56
6	31	35	24,500	925,600	....	....	71	30
7	33	19	8,900	3,850	....	....	58	55
8	149	157	12,175	1,950	....	....	47	53
9	37	32	....	4,000	....	....	30	24
Aggregate	1,782	1,721	358,275	530,392,518	....	316,000	4,529	76,144

At dams—	Other iron products.		Sand.		Gravel.	
	Up.	Down.	Up.	Down.	Up.	Down.
	Tons.	*Tons.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
1	4,620	18,268	3,247,500	719,100	2,826,500	45,000
2	4,590	6,258	769,400	1,788,000	1,026,200	37,000
3	3,627	347	118,500	785,000	254,600	4,000
4	2,726	287	346,100	....	178,100	2,000
5	2,707	296	55,100	....	273,050	....
6	1,434	167	19,800	1,600	17,500	2,100
7	908	214	6,200	2,200	2,950	....
8	425	126	2,980	2,366	3,200	2,000
9	349	124	47,550	1,000	8,000	1,000
Aggregate	21,386	26,087	4,613,130	3,199,266	4,580,100	93,100

At dams—	Stone.		Bricks.		Timber.	
	Up.	Down.	Up.	Down.	Up.	Down.
	Cu. yds.	*Cu. yds.*	*Number.*	*Number.*	*Cubic feet.*	*Cubic feet.*
1	2,405	4,515	43,800	93,000	3,043,500	215,300
2	225	4,762	169,700	3,000	2.468,000	225,735
3	2,310	477	810,700	21,000	976,472	515,100
4	265	630	164,300	....	740,600	544,100
5	....	1,290	264,450	100	5,000	664,725
6	3,347	230	116,100	31,000	5,000	576,100
7	124	427	....	412,500	500	507,872
8	2	950	....	426,000	1,000	512,520
9	....	200	....	399,100	375	296,950
Aggregate	8,678	13,481	1,069,050	1,385,700	7,240,447	4,058,402

At dams—	Lumber.		Lath.		Posts.	
	Up.	Down.	Up.	Down.	Up.	Down.
	Ft. B. M.	*Ft. B. M.*	*Number.*	*Number.*	*Number.*	*Number.*
1	13,301,500	216,800	993,000	....	494,280	....
2	9,650,330	193,762	724,000	....	441,661	....
3	4,822,300	1,055,294	467,000	35.400	408,652	5,060
4	2,866,200	1,433,5[illegible]	4,000	350,800	303,300	30,253
5	1,403,700	1,861,40[illegible]	341,650	16,000	74	188,405
6	603,640	1,999,831	179,600	6,000	4	172,392
7	78,500	1,698,800	9,000	1,000	4	156,130
8	42,200	1,530,659	8,000	5,000	6	152,230
9	24,000	1,223,560	....	17,450	....	131,500
Aggregate	32,792,370	11,213,651	2,721,250	431,650	1,647,981	885,970

Lockages made and traffic passed at Monongahela River locks during year ending June 30, 1901—Continued.

At dams—	Braces.		Ties, railroad.		Wood.		General merchandise.	
	Up.	Down.	Up.	Down.	Up.	Down.	Up.	Down.
	Number.	*Number.*	*Number.*	*Number.*	*Cords.*	*Cords.*	*Tons.*	*Tons.*
1	35,000	....	3,200	1,400	....	....	41,034	12,962
2	56,800	3,000	4,400	1,600	50	....	39,779	12,055
3	29,500	50	5,700	1,400	60	60	35,451	7,749
4	9,500	50	4,500	5,600	....	....	26,792	6,284
5	....	1,000	....	8,400	....	57	18,023	5,113
6	....	....	....	1,600	....	....	12,585	3,848
7	....	....	....	18,750	8	....	6,408	2,807
8	....	....	....	22,800	....	83	4,521	2,082
9	....	....	5,000	26,600	1	....	3,608	1,696
Aggregate	130,800	4,100	22,800	88,150	119	200	188,201	54,596

At dams—	Farm, dairy, and orchard products.		Live stock, large.		Live stock, small.		Passengers.	
	Up.	Down.	Up.	Down.	Up.	Down.	Up.	Down.
	Tons.	*Tons.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*
1	7,203	615	1,008	701	95	2,975	94,392	92,370
2	7,082	623	1,082	767	96	3,076	87,682	86,864
3	7,110	795	1,104	788	167	3,134	39,908	40,221
4	5,904	1,107	982	841	43	4,401	28,419	28,034
5	3,687	1,246	602	843	94	5,732	29,702	28,778
6	2,499	671	470	697	40	4,826	19,435	17,694
7	1,067	332	260	300	24	673	12,014	10,579
8	723	289	248	290	20	547	10,060	8,826
9	622	187	234	184	7	144	8,373	7,150
Aggregate	35,897	5,865	5,990	5,411	586	25,508	329,985	320,516

Maximum traffic at any one dam for fiscal year 1901.

Class.	Up.		Down.		Total tons.[a]
	Dam No.—	Tons.[a]	Dam No.—	Tons.[a]	
Coal[b]	1	7,648	3	5,952,080	5,959,728
Coke	....	....	1	7,900	7,900
Rails, steel	2	3,373	1	72,384	75,757
Other iron products	1	4,620	1	18,268	22,888
Sand	1	223,965	2	119,862	343,827
Gravel	1	194,931	1	3,103	198,034
Stone	6	3,938	2	5,602	9,540
Bricks	3	832	8	1,278	2,210
Timber	1	83,696	5	18,280	101,976
Lumber	1	26,603	6	4,000	30,603
Laths	1	223	4	79	302
Posts	1	24,712	5	9,420	34,132
Braces	2	2,272	2	120	2,392
Ties, railroad	3	570	9	2,660	3,230
Wood	3	90	8	125	215
General merchandise	1	41,034	1	12,962	53,996
Farm, dairy, and orchard products	1	7,203	5	1,246	8,449
Live stock:					
Large	3	552	5	422	974
Small	3	10	5	344	354
Total	....	626,372	....	6,230,135	6,856,507
Number of passengers carried	1	94,392	1	92,370	186,762

[a] 2,000 pounds.

[b] Monongahela River coal output for fiscal year 1901 was 6,107,172 tons.

Traffic summary from maximum of different classes at any dam.

Fiscal year.	Products.	Passengers.
	Tons.	*Number.*
1898	6,117,973	157,098
1899	6,954,955	163,215
1900	5,994,975	192,652
1901	6,856,507	186,762

a 2,000 pounds.

H H 4.

IMPROVEMENT OF HARBOR AT PITTSBURG, PENNSYLVANIA.

Dredging channel way.—The widening of the channel made during previous year in the Monongahela River, below the Tenth Street Bridge, was undertaken in September and completed in March, after several unavoidable interruptions. From that bridge to the Panhandle Railroad bridge the improvement project was finished. From the railroad bridge downstream to deep water, about opposite Market street, Pittsburg, the required channel of 10 feet depth at pool stage was widened to 300 feet. The amount dredged was 80,075 cubic yards, and cost 15.7 cents per yard. Thirty-seven hours' work of dredging plant, at $10 per hour, were occupied in removing large stones, principally, stumps and riprap of old bridge piers, sunken timbers, old pipe, and an abandoned oil tank swept from the river bank by high flood, lodged against the Panhandle Railroad bridge and then sank in the channel below. The dredgings were mainly coarse gravel, with numerous stones, and were disposed of, together with the large stones, by dumping in deep water below Dam No. 1 or in sand, digging holes at sides of head of Brunot Island. The oil-tank pieces were sold at public auction.

Effort to have river sand diggers dredge in connection with their sand and gravel business at shore bar in Ohio River, between Locust and Juniata streets, Allegheny, was a failure; same as to shoal at mouth of Allegheny River was a partial failure. At Garrison Bar, however, in the Allegheny River, above head of Herr Island, where the sand and gravel are good and there is not much waste, the opening of the channel began in the previous year was completed through control of work of sand diggers, thereby extending natural low river navigation into the long pool above. The cut is about 1,200 feet long and of 150 feet average width. The channel at bad shoal in head of Ohio River, in line with right channel span of the Union Bridge, was improved by requiring work of sand diggers there to be made along proper lines for the purpose.

Brunot Island dam.—The top covering of stone was extended at the island end of dam by the Jutte & Foley Co., in final completion of its work of previous year; 155 cubic yards of stone were used in the extension of covering. An examination during a very low water in December showed that the stone was well placed and the dam in good condition.

Removal of abandoned structures.—On request, the Baltimore and Ohio Railroad Company removed about 140 old pile stubs from the Monongahela River near Glenwood, being remains of a former ferry car-transfer incline belonging to that company. One coal tipple and three protection cribs at Green Springs, Pool No. 1, Monongahela River, were also removed.

Marking harbor lines, inspection and patrol.—On the Monongahela River a system of triangulation was made and computed from the Pittsburg and Lake Erie Railroad bridge at Homestead to Lock No. 1, a distance of 7 miles, for locating established lines on the ground and for connection with original harbor-line survey, 1891. The lines were marked by lettered surface posts, and by lead plugs or lettered cuts in iron and masonry structures for about 12,000 feet on the right bank and 14,000 feet on the left bank.

On the Allegheny River the harbor lines were likewise located and marked, on right bank from the Union Bridge to the Sixth Street Bridge, and on both banks from the Sixteenth Street Bridge to the Thirtieth Street Bridge, an aggregate distance of 8,500 feet; also for short distances at the Frank-Kneeland Machine Company works and foot of Fortieth street, Pittsburg.

On the Ohio River the harbor line was run on right bank from Union Bridge to foot of Belmont street, Allegheny, 3,000 feet; from Ohio Connecting Railroad bridge to penitentiary building, 1,500 feet, and on left bank at Pressed Steel Car Works, below McKees Rocks, 500 feet.

Inspection of constructions of various kinds near harbor lines, and of permit structures between the lines, was made at many places in the harbor for prevention of unauthorized encroachments or to secure compliance with terms of permits. The patrol of the rivers and banks throughout the harbor and supervision of the work of sand diggers was continued during the year, resulting in prevention of improper deposits in the river and on the banks, or removal of same if found already done, in a large number of cases, and in imparting knowledge of the laws about river encroachments to river property owners and their employees. Signboards bearing notices against dumping refuse on or over river banks were renewed at several places and a number of new boards erected. The cases of two steamboat masters and dredge foreman, held by the United States commissioner near the end of the previous year for trial on the charge of illegal dumping in the harbor, came before the grand jury in October; true bills were returned against the parties. The steamboat masters were fined $500 each; sentence of dredge foreman was suspended. The master of one of the sand dredgers, failing to remove a pile of refuse deposited from his boat, was brought before the United States commissioner, but, on promise of removal of the refuse and future observance of the laws, was not held for trial. The dumping of night soil in the rivers was investigated and steps taken to have the extensive illegal practice thereof stopped.

Harbor lines and permits for river structures, etc.—A public hearing was held and examination made, July 2, 1900, by a Board of Engineer officers, upon application of the Jones & Laughlin's interests, for change of harbor line on Monongahela River below Hazelwood avenue. The board made an unfavorable report. Applications for permits were reported upon, after examinations which included, in many cases, surveys, mapping, and studies more or less extensive, as follows:

Monongahela River.

National Tube Company,* coal dock and hoist, near Four-mile Run.
Rodgers Sand Company,* dredging sand, etc., in all the harbor.
Jones & Laughlins,* pedestals for coal conveyer, near Laughlin street.
City of Pittsburg,* reconstruction of Tenth Street Bridge.
City of Pittsburg, modification of plans of same.
N. G. Macrum, protesting against location of United States harbor line near and above Lock No. 1
W. H. McCloskey, to operate float in Monongahela River for unloading night soil in river.
Protests by John Clark and the superintendent of Pittsburg bureau of health against interference with the practice of dumping night soil in river.

Allegheny River.

Crucible Steel Company,* coal hoist, etc., near Thirteenth street.
Allegheny County Light Company,* intake pipes, near Twelfth street.
Pittsburg Junction Railroad Company, change of United States harbor line along Wainwright Island.

Ohio River.

Pittsburg and Western Railway Company,* two car-transfer inclines, near foot of Brunot Island.
Pittsburg and Western Railway Company,* change of harbor line, right bank, below Union Bridge.
C. Jutte & Co.,* temporary pile wharf, near Ohio Connecting Railroad bridge.
Pittsburg and Western Terminal Railroad Company,* change of location of transfer incline, below foot of Brunot Island.
Lockhart Iron and Steel Company,* water intake pipe, McKees Rocks.
United Traction Company,* water intake pipe, Juniata street, Allegheny.
Congressional bill to authorize bridge across Ohio River from Preble avenue, Allegheny, to McKees Rocks.

Permits were granted by the Secretary of War for structures and dredging named above and marked *, and supervision of same undertaken, as required by terms thereof, in cases where the works were commenced.

Extension of harbor lines, Homestead to Youghiogheny River.—The proposed lines were marked on the ground for information of riparian owners at places where requested. Strong written protest was filed by city of McKeesport against any harbor lines whatever outside (toward river) of actual former banks for the part of Monongahela River above Dam No. 2. Other representations in reference to the matters were received, including notice of intended request of modification of the lines as laid down at the National Tube Works frontage.

Miscellaneous.—The heights of four floods and a low-water stage, occurring during the year on the Allegheny and Monongahela rivers, were marked, levels of the points taken, and the river slopes plotted. The heights and profile of lowest points of superstructure were obtained by levels and measurements of 13 bridges on the Monongahela River and 9 bridges on the Allegheny River. The heights of steamboats, dredge boats, and other high craft plying in the harbor were measured. A new gauge was fixed at a pier of the Point Bridge, and elevations of old gauges at Market and Smithfield streets and Lock No. 1, Monongahela River, were checked by duplicate levels from established bench marks.

The patrol boat *Loma* was docked in November, hull cleaned and painted, calking repaired, iron sheathing placed on bow, and the hog chains, rudders, and tillers repaired. In June the wheel was rebuilt and changed to divided bucket type to reduce vibration on the boat.

It is expected to apply the available balance in completion of existing project for dredging channel way below Dams No. 1, Monongahela and Allegheny rivers, removal of abandoned structures in river and, as far as proper, bank projections beyond established harbor lines, and purchase of patrol launch. The recommended appropriation is for a year's maintenance and continuance of works and services.

Money statement.

July 1, 1900, balance unexpended	$88,174.52
June 30, 1901, amount expended during fiscal year	26,961.64
July 1, 1901, balance unexpended	61,212.88
July 1, 1901, outstanding liabilities	8,017.22
July 1, 1901, balance available	53,195.66
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement, in addition to the balance unexpended July 1, 1901	10,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

APPROPRIATION.

March 3, 1899	$110,662.90

COMMERCIAL STATISTICS.

The routes of 6 Ohio River and 3 Monongahela River packet lines, using 20 steamers for passengers and freight, terminate at Pittsburg. The total water-borne tonnage of the harbor and number of passengers carried for 1900 are found by careful compilation to be 8,141,451 and 844,415, respectively. Decrease from previous year is due mainly to stoppage of the transfer by boats of railroad cars between points on the Allegheny River. The principal item of tonnage is coal for local consumption and shipment down the Ohio River. The passenger item is made up largely by local excursion and ferry traffic. Classified statement for calendar year 1900 follows:

Commodities.	Tons.[a]	Commodities.	Tons.[a]
Barges and flats, new	7,901	Palings	40
Bark, tan	1,591	Piles	3,144
Bauxite	1,500	Pig iron	4,971
Bottoms, coal-boat, new	26,748	Pipe, sewer	120
Bricks	8,301	Poles, brace	1,226
Cars, loaded	172,416	Posts, pit and check	9,999
Cars, empty	17,772	Sand	784,925
Coal	6,186,128	Shingles	145
Coke	1,512	Steel rails	84,965
Farm, dairy, and orchard products	24,578	Steel and iron products, miscellaneous	54,237
General merchandise	106,625		
Gravel	423,555	Stone	23,948
Lath	689	Ties, railroad	876
Lumber	61,333	Timber	152,967
Live stock, large	4,822		
Live stock, small	417	Total	8,141,451
Manure	12,500		
Miscellaneous	12,000	Passengers ..number	844,415

[a] 2,000 pounds.

H H 5.

CONSTRUCTION OF LOCKS AND DAMS AT HERR ISLAND, ABOVE HEAD OF SIX-MILE ISLAND, AND AT SPRINGDALE, ALLEGHENY RIVER.

The contractors for completing Herr Island Dam except the two bear-trap gates, and for building two guide cribs at the lock, finished and maintained cofferdam built from the side of the river opposite the lock; constructed their section of the navigable pass, except part setting of irons and erection of wickets; built the greater part of concrete pier adjoining; made remaining excavation; drove sheet piling at upstream edge of dam to face of abutment, and constructed the cribs below the weirs, except decking. The contractors also completed the lower guide crib at the lock, except its paving, and built the upper guide crib, including stone ballast, to within 1½ feet of its height. The original time for completion of structures under this contract was October 1, 1900, but extensions were granted from time to time, the last extension expiring September 1, 1901.

The progress of the work is now good and it promises to be finished at expiration of time. The contractor for furnishing and erecting the bear-trap gates is ready for his part of the work, so that this dam, whose main construction under two different contracts since 1898 has been beset with difficulties and delays from various causes, should be fully completed by December next.

Under hired labor operations the upper miter sill of Herr Island Lock was lowered 2 feet, as authorized, and in order to give the same depth at head of lock as at its foot. The work and removal of bulkheads were done in September and October. It comprised the taking up of the 2-foot stone miter sill, sill cushions, and gate pivots; cutting down the 10-foot wide concrete guard sill, gate recesses, pivot and sill cushion recesses, form piles, forms, and timber guard sill, from 1 to 2 feet; cutting and rethreading sill cushion and pivot bolts; resetting sill and quoin cushions and pivots, and surfacing with cement mortar, or concrete the sill walls and hollow quoins. The change in useful depth through the lock was from the first an accommodation to boats, which on a low natural river passed through the open lock when they could not have gone over the sill of the navigable pass.

The contractor for the Six-mile Island and Springdale locks and dams worked at Springdale. The cribs and lower guide wall at the lock were completed except paving of the high cribs, and valves and sill cushions set during first quarter of year. Dredging at site of abutment and section of dam on that side was also done; but floating plant and material for dam construction were not assembled at the work in time, and a very low water, stopping all navigation, obtained until the November flood, when it was not advisable to continue further effort for work that season. Operations were resumed early in the present season; dredging at abutment and for adjacent part of dam was done, and the large abutment and adjoining apron cribs built and placed.

The extract below is from report by Assistant Engineer J. W. Arras. During this gentleman's absence, December–February, Engineer Superintendent R. G. Doerfling acted as assistant at Herr Island Dam.

Lock and dam at Herr Island (*No. 1*).—There were under way at the beginning of the year the erection of a cofferdam and excavation for foundations. Although the conditions were exceptionally favorable the progress made was discouragingly slow. The cofferdam was finished on August 20. Instead of having an adequate pumping plant installed, capable of quickly disposing of the water in the inclosure, this machinery came in piecemeal, and twenty days later three pumps were in place. These were all second-hand articles, and one engine was in such a dilapidated condition that it could only be made to run a few hours at a time.

Necessarily pumping under such adverse conditions proved a failure and naturally the contractor sought for some cause other than his incompetency on which to place the blame. He conceived the idea that excessive leakage issued from the finished end of the Chanoine Dam, and accordingly, on September 10, without submitting the question to the engineer officer in charge and contrary to the express provisions of the specifications, opened communication between the main inclosure and the small compartment at the end of the finished work by cutting the cofferdam wall which separated them. There was at that time a difference of 9 feet between the water surfaces in the two inclosures. If there were no leaks of consequence around the bulkhead through the end of the apron crib below the Chanoine Dam, the instantaneous application of a 9-foot head of water was sufficient to produce some, and immediately after cutting the dam so much water issued from the small compartment as to exceed, in addition to the leakage in the main inclosure, the pumping capacity of the plant, which already had been taxed to its limit. The contractor then shut down his pumps and proceeded to deposit excavated material about the cofferdam in order to stop the leaks. This comparatively useless work was permitted to continue until September 19, when he was peremptorily ordered to restore the broken cofferdam and proceed in accordance with the specifications. The order was promptly complied with, and in a few days the water was down to the limit of reach of the pumps. Nearly three weeks were devoted to lowering the pumps and installing a new one which had been received. On October 14 the inclosure was empty. On the 18th construction work was commenced on the foundations, nearly three months later than might have been under proper management.

In the meantime attention was directed to shutting off the leaks which had occurred in the bulkhead in the end of the finished portion of the Chanoine Dam. Either to locate and afterwards to stop such leaks 20 feet under water and in the bottom of an open structure extending halfway across the river will readily be conceded as no easy task. Therefore, and because of the nature of the management displayed by the contractor, the supervision of the undertaking was accomplished by the Government's engineering and inspection force, and in order to hasten its completion even some of the labor performed by them.

* * * * * * *

All of the construction work within the empty inclosure during the season of 1900 was performed between October 18 and November 25, a period of thirty-eight days, in which considerable time was lost in setting up operating plant, repairing disabled machinery, etc. When the November rise occurred, which on the 27th reached a stage of 28.2 feet above low water at the dam, the timber work of the apron cribs below the dam was built from the bank to within about 50 feet of the finished end of the Chanoine Dam, the crib work well filled with stone, the excavation made, and sheet piles for the concrete foundations, except about 50 feet of the navigable pass, driven, the concrete pier at end of Chanoine Dam built to within 3 feet of the main sill level of the dam, and the concrete foundation of the Chanoine Dam built to approximately the same elevation for a length of nearly 100 feet. Although the contractor had timely warning of the approach of the November freshet, he removed none of his machinery to a place of safety, and consequently most of it was dislodged, the derricks knocked down, and several articles carried away by the water.

When high water occurs at this season of the year it is customary here to suspend operations for the winter, since the frequent freshets, ice, and inclement weather render operations very difficult and uncertain, and the quality of the work done often deficient in some respects. However, the state of this work was such at this time as to render winter construction a necessity. From the lock 350 feet of dam was finished, and from the opposite bank cribs and concrete foundations to the same level were partly constructed for about 300 feet, leaving a gap 50 feet wide by 16 feet deep, from low water, between them in the middle of the river. Should the cofferdam undermine or otherwise give way at the outer end and permit the water to flow unobstructedly through this gap for a time, enormous scour would assuredly ensue and the ends of both structures settle down, causing damage which might readily exceed $50,000, besides great delay to the work. With a view to closing the gap, pumping was resumed on December 14, and when the rise of January 11 occurred the navigable-pass apron crib was connected to a height of 8½ feet. On January 24 the contractor again began pumping and resumed construction work ten days later. All of the sheet piles were in place on February 12 and the apron crib completed on the 21st. The placing of concrete was commenced on the 16th and continued until March 4, when 805 cubic yards had been put in, bringing the foundation of the Chanoine Dam up to within a few inches of the level of the bottom timbers of the floor. Owing to the low temperatures gravel and sand for concrete were heated in boxes by means of perforated pipes in them for the introduction of steam. * * * After March 4 frequent rises occurred, the highest—28.6 feet—on April 26, and apart from maintaining the cofferdam, which sustained considerable damage, requiring 5,000 feet B. M. of lumber and 655 cubic yards of filling to repair, nothing could be done until the latter part of May, and uninterrupted construction work not until June 10. At the end of the year the floor of the Chanoine Dam was well under way, and the concrete pier at its end built to the level of the main sill of the dam at the upper end and about 4 feet higher at the lower end.

Both guide cribs at the lock were started in July, and sunk into place and partly filled with stone in October. During the winter the lower one was built to its final height and ballasted to the paving line, and the timber work of the upper crib has also been nearly completed and the crib filled with stone. One hundred and fifty-four cubic yards of large stone were placed around the head of the upper guide crib to prevent its undermining.

Owing to the contracted condition of the waterway at the dam, the lock and cofferdam occupying more than one-half of the river bed, heavy scour took place below the navigable pass, in some places extending to a depth of 11 feet below the top of the pass sill. While not endangering the dam, yet because of its effect on the lower guide crib, which it undermined slightly, and to prevent possible scour to a still greater depth, 532 cubic yards of large, rough stone were placed in the trench, together with 5,220 cubic yards of material dredged from bars above and below the ends of the lock. Later the contractors for constructing the Pennsylvania Company's bridge piers, a short distance below the dam, were given permission to deposit about 3,000 cubic yards of their dredged material, principally rock, in the same place, restoring the river bed about to its original elevation, and protecting the guide crib until the cofferdam can be removed.

In addition to the wickets and irons pertaining thereto, valves, pipes, etc., furnished by the United States, the following quantities of materials, furnished by the contractor, were put in place and work performed:

Piles	number..	34
Timber in cribs	linear feet..	450
Oak lumber	feet B. M..	216,065
Hemlock lumber	do....	292,492
Iron bolts	pounds..	50,934
Stone, ballast and protection	cubic yards..	5,320
Concrete	do....	1,753
Excavation and cofferdam filling	do....	11,083

The irons for the fixed parts of the bear-trap weirs, 63,000 pounds, were delivered at the site of the work; also all valves, pier nosings, pipes, etc., for the bear traps, and the irons and most of the timber for the lock gates were received during the year.

In the summer of 1900 materials were purchased, 146 linear feet of cofferdam constructed across the ends of the lock, the inclosure unwatered and the upper guard and miter sills, gate recesses, etc., cut down 2 feet, thus reducing them to the same elevation as the sills at the lower end of the lock; lock walls dressed and 2 coats of a waterproof cement wash applied to both faces of the lock walls, fixed dam and to the retaining wall at the Government lot, the work being completed by a small force of hired labor in sixty days. Subsequently the cofferdams were removed.

* * * * * * *

Lock and dam at Springdale (No. 3).—Very little was accomplished during the year. Some dredging was done for the abutment. The submerged crib outside of the river wall of the lock and below the dam was completed; the guide cribs at head and foot of river lock wall were finished except paving, and the concrete guide wall at foot of land wall completed. The emptying valves, lower miter and guard sills, and lower sections of hollow quoins were placed in the lock, and the lock walls given 2 coats of waterproof cement wash. Late in the season of 1900 some dredging for the abutment end of the dam was done and a trial made of driving rectangular sheet piling along the upstream edge of the dam, which, however, failed to give satisfactory results. Afterwards a few round piles were driven to much better effect.

Early in the present season preparations were made for constructing the dam. In May dredging for the abutment began and continued until the end of the fiscal year. The main abutment crib, 12 feet by 160 feet by 16 feet in height, was built and sunk in place, and a submerged crib adjoining, having the same length as the main crib and 40 feet wide, was built ready to sink. Considerable excavation for the dam was also made.

None of the permanent work suffered any injury during the year, although the excavated trenches for dam filled in heavily during the winter and will need to be reexcavated.

The remainder of the irons for the lock and lock gates were purchased and have been delivered at the site of the improvement.

Statement of materials placed and work done:

Earth excavation and dredging	cubic yards..	15,650
Hardpan excavation	do....	23
Concrete, natural cement	do....	31
Concrete, Portland cement	do....	337
White oak lumber	feet B. M..	84,950
Hemlock lumber	do....	42,540
Oak piles	number....	183
Drift bolts	pounds....	15,334
Riprap stone filling	cubic yards....	1,556

The status of the work at Six-mile Island is about the same as given on page 484 of Annual Report of Chief of Engineers, 1900, except that the Recorder of the city of Pittsburg, its executive, has lately advised me that attention to the matter would be given at an early date.

It is expected to apply the available balance and additional appropriation recommended to completion of existing contracts, purchase of remaining land for Six-mile Island dam, erection of lock buildings, and for operating machinery for the locks and dams.

Money statement.

July 1, 1900, balance unexpended	$398,546.19
Amount appropriated by sundry civil act approved March 3, 1901	126,000.00
	524,546.19
June 30, 1901, amount expended during fiscal year	88,346.56
July 1, 1901, balance unexpended	436,199.63
July 1, 1901, outstanding liabilities	32,150.81
July 1, 1901, balance available	404,048.82
July 1, 1901, amount covered by uncompleted contracts	419,819.91
Amount (estimated) required for completion of existing project	118,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	118,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

August 5, 1886	$37,500	June 4, 1897	$350,000
August 11, 1889	35,000	July 1, 1898	300,000
September 19, 1890	35,000	March 3, 1901	126,000
July 13, 1892	40,000		
August 18, 1894	40,000	Total	1,013,500
June 3, 1896	50,000		

CONTRACTS IN FORCE.

1. With Sloan, McIlvain & Ott Bros., Allegheny, Pa., for constructing two locks and dams on Allegheny River at Six-mile Island (No. 2) and at Springdale (No. 3).
Date of approval, July 8, 1897.
Date of beginning work, May 25, 1898.
Date of expiration, September 26, 1901.

Rates.

		No. 2.	No. 3.
FOR LOCKS AND ABUTMENTS.			
Grubbing and clearing		$13.00	$142.00
Earth excavation	per cubic yard	.22	.12
Hardpan excavation	do	.75	.75
Rock excavation	do	1.75	1.75
Embankment	do	.48	2.19
Concrete of natural cement	do	3.59	4.18
Concrete of Portland cement	do	4.99	5.57
Stone filling in cribs	do	1.25	1.00
Stone paving of cribs	per square yard	1.20	1.10
Stone paving of river bank	do	1.50	1.40
White oak in gates	per M. feet B. M.	47.00	47.00
White oak in quoins and sills	do	60.00	60.00
White oak in cribs, abutments, and gate spars	do	44.00	44.00
Hemlock in cribs	do	19.50	19.50
Button-head driftbolts	per pound	.017	.017
FOR DAMS.			
White-oak timber	per M. feet B. M.	30.00	30.00
Hemlock timber	do	19.50	19.50
White-oak sheeting on back of dam	do	28.00	28.00
Riprap stone filling	per cubic yard	1.00	1.07
Button-head driftbolts	per pound	.017	.017
Dredging foundation	per cubic yard	.17	.16
Refilling for dam	do	.16	.15
Backing of dam	do	.15	.15
Hemlock piles in place	each	4.32	4.32
Hemlock sheeting and scantling in foundation	per M. feet B. M.	16.00	16.00

2. With Edward J. Hingston and Olaf R. Pihl, Buffalo, N. Y., for building cofferdam, foundation, piers, and abutment for part movable dam and guide cribs, and erecting Chanoine wickets at Herr Island lock and dam, Allegheny River, Pennsylvania.
Date of approval, June 8, 1900.
Date of beginning work, June 12, 1900.
Date of expiration (construction part), July 15, 1901.

Rates.

Piles	each	$6.00
Oak lumber in cofferdams	per M. feet B. M.	45.00
Hemlock lumber in cofferdams	do	26.00
Timber in protection cribs	per linear foot	.20
Oak timber in apron cribs	per M. feet B. M.	39.00
Hemlock timber in apron cribs	do	26.00
Oak timber in foundation of dam	do	39.00
Oak timber in guide cribs	do	39.00
Hemlock timber in guide cribs	do	25.00
Screw bolts and tie rods	per pound	.05
Drift bolts in apron and protection cribs	do	.03
Drift bolts in guide cribs	do	.03
Filling in cofferdam	per cubic yard	.90
Stone ballast in apron and protection cribs	do	2.85
Stone ballast in guide cribs	do	2.60
Stone protection for apron cribs	do	3.10
Stone protection for upper guide crib	do	3.60
Stone paving in guide cribs	per square yard	1.60
Gravel excavation	per cubic yard	.30
Concrete	do	5.67
Pumping during erection of bear-trap gates, per day (24 hours)		10.00

3. With Thomas Marshall, Pittsburg, Pa., for building and erecting 2 bear-trap gates at dam at Herr Island, Allegheny River, near Pittsburg, Pa.:

Date of approval, July 11, 1900.

Date of beginning work, July 1, 1900.

Date of expiration, about December 1, 1901, depending upon time of readiness of foundations.

Rates.

Furnished and delivered:		
Cast iron	per pound	$0.04
Wrought iron	do	.06
Wrought steel	do	.05
Furnished and erected in place:		
Oak timber in upper gates	per 1,000 feet B. M.	98.00
Bronze	per pound	.40
Springs, steel	do	.08
Cast iron	do	.035
Wrought iron, bolts, spikes, etc	do	.07
Steel castings	do	.10
Wrought steel	do	.0583
Painting ironwork of 4 gates		1,000.00

COMMERCIAL STATISTICS.

[Compiled at United States Engineer Office, Pittsburg, for showing commerce on part of river under slack-water improvement, including upper river traffic transported into and from Pittsburg Harbor, for calendar year 1900.]

Articles.	Quantity.	Articles.	Quantity.
	Tons. [a]		*Tons.* [a]
Barges and flats, new	7,901	Machinery, pipe, etc	1,653
Bark	1,591	Manure	12,500
Bauxite	1,500	Palings	40
Bottoms, coal boat, new	26,748	Piles	3,144
Brick	4,820	Pipe, sewer	120
Cars, empty	17,772	Poles, brace	1,226
Cars, loaded	172,416	Posts, check	1,164
Coal	516,762	Posts, pit	8,835
General freight	3,232	Ties, railroad	376
Gravel	247,668	Sand	438,472
Hay	216	Shingles	145
Iron, scrap	480	Stone	14,905
Iron, structural	1,977	Timber	80,293
Iron, in pigs	2,800		
Lath	689	Total	1,611,103
Live stock, small	173		
Live stock, large	26	Passengers, number	36,525
Lumber	41,959		

[a] 2,000 pounds.

It has always been difficult to secure statistics of commercial movements on the Allegheny River, and while a special effort was made this year to get reliable reports of shipments, yet the results are not fully satisfactory and can only be regarded as an approximation which may vary considerably from the actual tonnage handled. Coal deliveries on lower 3 or 4 miles of river diminished from preceding year, mainly on account of long duration of high water, which prevented boats from passing under numerous low and otherwise obstructive bridges. River transfer of railroad cars was wholly discontinued, causing a considerable loss of river tonnage as compared with that of previous year.

H H 6.

IMPROVEMENT OF ALLEGHENY RIVER, PENNSYLVANIA.

A list and description of the improvement structures are given on pages 2425 and 2426 of annual report for 1897. Illustrations of the principal works follow page 2206 of the report for 1898; a description of Red Bank dike extension appears on page 2202 of same.

Nicholson Dam.—The rebuilding of this structure, undertaken during the previous year, was unavoidably then unfinished. The work stood the winter's ice and rises, but heavy spring freshets scoured considerably below the dam, resulting in a sinking of the structure at places of an aggregate length of about 200 feet, the loss of several timbers of its lower slope, a disruption and removal of much of the upper slope paving and a scouring out of the filling underneath.

Only a small amount of funds was available for repairs of this dam. Nearly all the timber and bolts required for reconstruction had been procured the previous season, and the portions not then used stored near the site. Work was begun August 22. Depressed portions of the cribwork were built up, ballasted and paved, slopes repaired, riprap protection below the dam added, and the whole structure put in as good condition by the end of October as funds permitted. Stone used in the work was recovered from the old structure and the river bed adjacent, except a few hundred yards obtained by blasting large bowlders lying about a mile below the dam in the island chute. The length of the dam rebuilt during the two years is 998 feet, width 27 feet, and height about 3.5 feet above low water. Heavy paving, at the least 18 inches in depth, is required for this dam, but funds would not permit the expense for that; hence old stones which were too small, and many of them poorly shaped, were used because they could be procured cheaply and it was not desired to run the risk of a serious breach in the dam. This substitute made a light and rather loose pavement, and although carefully laid, the past winter's ice and freshets, more than ordinarily frequent and destructive, damaged part of the paving and allowed filling at this portion to be scoured out.

Red Bank dike.—Considerable repair was made during August and September to the filling and paving of the middle portion, about 300 feet long, of this structure, and several hundred yards of bowlders removed from the channel were deposited along the face of the dike. The timber work of the older and upstream portion of the dike was badly decayed, especially at the crest, and should have been renewed, or, better, decayed timbers removed, top flattened and heavily paved; funds did not permit either repair; consequently much damage for a length of about 100 feet at this portion of the dike was done by the ice of last winter.

Other works.—Small repairs as needed were made to the Corydon log chute, Hickory and Pithole dams, and upper Cowanshannock dike. The remaining improvement structures were in good condition during the year.

Open channel improvement.—In middle September, the river having reached low stage, three parties, each consisting of a suboverseer, 8 laborers, and 2 teamsters with teams, began removal of rock and other obstructions between Hickory, 161 miles above Pittsburg, and New

Kensington, near middle of upstream pool of authorized slack-water improvement. The distance covered, 142 miles, was divided into three sections of about equal length. The parties worked downstream, moving with outfits from point to point on coal-boat bottoms, having rough houses for quarters and sheds for horses. One of the parties returned by land to work at a very few bad places not finished on the down trip; all of them worked from four to six weeks or until the first river rise interfered, when it was arranged to close operations for the year. About 2,700 cubic yards of bowlders and 350 of gravel and 14 snags were removed from the low water running channel, restoring it to good condition. Some deterioration has now obtained, as might be expected from the character of the river, but the thorough cleanings of this part of the channel in late years have made future work, if done yearly, comparatively small.

During late years the head of principal navigation on the river has been at Hickory, and hence improvements have been confined almost exclusively to the stream below that point. During the past year, however, large tracts of timber in the vicinity of Warren have been purchased by operators and extensive sawmills and a boat yard established at Irvinton for river shipments of lumber, barges, and coal-boat bottoms. This has now extended the navigation head 30 miles farther upstream. Since little attention has heretofore been given to this section of river and none at all in recent years, the need of a thorough cleaning out of obstructions from the low-water channel over it is now felt. It will require several years to exhaust the product of the new timber tracts now open to trade.

It is expected to devote the available balance of funds to a cleaning of the low-water channel from Hickory to New Kensington, and to minor repairs for temporary maintenance of Nicholson Dam and Red Bank dike. The additional appropriation recommended is for thorough open-channel work from Warren to Hickory, a year's maintenance of channel below Hickory, improvement at Nicholson and Red Bank, and minor repairs at the other contraction works.

Money statement.

July 1, 1900, balance unexpended		$2,582.71
Amount allotted August 17, 1900, by Secretary of War		5,000.00
		7,582.71
June 30, 1901, amount expended during fiscal year		5,393.15
July 1, 1901, balance unexpended		2,189.56
July 1, 1901, outstanding liabilities		26.17
July 1, 1901, balance available		2,163.39
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901:		
For works of improvement	$11,000.00	
For maintenance of improvement	4,000.00	
		15,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

APPROPRIATIONS.

March 3, 1879	$10,000	July 13, 1892	$25,000
June 14, 1880	20,000	August 18, 1894	12,500
March 3, 1881	25,000	June 3, 1896	12,500
August 2, 1882	15,000	March 3, 1899	15,000
July 5, 1884	35,000	June 6, 1900 (allotment)	5,000
August 5, 1886	30,000		
August 11, 1888	25,000	Total	250,000
September 19, 1890	20,000		

COMMERCIAL STATISTICS PERTAINING TO PART OF RIVER ABOVE AUTHORIZED SLACK WATER.

[Compiled at United States engineer office, Pittsburg, for calendar year 1900.]

Articles.	Tons. a	Articles.	Tons. a
Barges, new	8,040	Manure	600
Bottoms, coal boat, new	26,748	Hay	216
Flats, new	872	Building stone	19,259
Lumber	42,616	Other stone	26,765
Timber	84,858	Brick	20
Lath	692	Sand	137,474
Palings	40	Gravel	75,000
Piles	3,144	Live stock, large	173
Brace poles	1,226	Live stock, small	26
Check posts	1,164	General freight	926
Pit posts	8,835		
Shingles	145	Total	439,801
Railroad ties	376		
Bark	1,591	Passengers ... number	1,525

a 2,000 pounds.

The main part of river trade consists of rafting, running downstream of new barges and coal-boat bottoms with loads of lumber, hay, tan bark, piles, etc., and moving sand, building stone, and gravel.

Packet business was done by the steamboat *Nellie Hudson*, making trips almost daily between Pittsburg and Kittanning from March 1 to April 15. The *Lee H. Brooks* did some towing of sand to Kittanning.

The traffic taken in parts of river gives approximately the following:

	Tons.
Above mouth of Clarion River to Pittsburg	55,460
Below mouth of Clarion River to Pittsburg	19,465
Out of Clarion River to Pittsburg	110,352
Above mouth of Clarion River, not reaching Pittsburg	1,936
Below mouth of Clarion River, not reaching Pittsburg	252,588

H H 7.

MODIFICATION OF HARBOR LINES IN OHIO RIVER AT ALLEGHENY CITY, PENNSYLVANIA.

THE PITTSBURG AND WESTERN RAILWAY COMPANY,
OFFICE OF PRESIDENT AND RECEIVER,
Allegheny, Pa., June 27, 1900.

DEAR SIR: I herewith send you, in triplicate, white prints[1] showing certain property belonging to the Pittsburg and Western Railway Company, located in Allegheny City, Allegheny County, Pa., and which, at the time of the establishment of the harbor line by the United States Government engineers in 1895, was taken possession of and made a part of the river bed.

---

[1] Not printed.

This ground is a part of a purchase of what is known as the "Smoky Island property" by the Pittsburg and Western Railway Company, and for which a large sum of money was paid.

We think that an investigation of the subject will warrant the United States Government in reestablishing the harbor line at point indicated and restoring to us that portion of our property shown on plan attached (located between the harbor line and the State commissioner's high-water line established in 1858, and comprising some 4.54 acres), as it has largely been filled up, and, we believe, does not in any sense interfere with marine navigation.

I would, therefore, be obliged if the Department will have the subject investigated with a view to granting the release of the property we seek.

Yours, truly,

THOS. M. KING,
Receiver.

Hon. ELIHU ROOT,
Secretary of War.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
July 2, 1900.

Respectfully referred to Maj. Chas. F. Powell, Corps of Engineers, for report.

To be returned.

By command of Brig. Gen. Wilson:

A. MACKENZIE,
Lieut. Col., Corps of Engineers.

[Third indorsement.]

U. S. ENGINEER OFFICE,
Pittsburg, Pa., September 12, 1900

Respectfully returned to the Chief of Engineers, United States Army.

This is an application for change of harbor lines from its present establishment to the old Pennsylvania State commissioners' high-water line, from Grant avenue, Allegheny City, downstream along right bank of Ohio River to property of Allegheny Gas Company.

I find that a certain change of harbor line here would be advantageous to the harbor in that it would better preserve and protect the harbor. The modified harbor line recommended by me on that account for adoption is shown, together with the present established harbor line, other water and bank lines, and outline of existing shoal at mouth of Allegheny and head of Ohio rivers, on blue print[1] herewith, in triplicate, of the harbor-line map. The modified line starts from a point farther upstream, is first directed farther riverward, and then farther landward, and is extended farther downstream, than the changed harbor line applied for. To terminate the modified line at the downstream end of the railroad property would make an awkward disposition of it, and hence it was extended along the properties of the Allegheny Gas Company, Pittsburg Clay Pot Company, and American Steel Hoop Company to a suitable connection with the existing harbor line, and also for aiding in removal by scour of the lower end of the shoal named above.

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[1] Not printed.

The project for improvement of Pittsburg Harbor intends a channelway of 10 feet depth at pool stage. This project, the existence of the extensive shoal at the locality, and dredging now being conducted there and contemplated for the future, have been carefully considered in selecting the recommended line.

The interests of the said properties have expressed their assent to the modified harbor line as recommended; at first the gas company demurred, then asked for time to look into the matter and subsequently withdrew all objection. The upper end of said modified line falls upon the railroad company's property. Mr. King, president of the railroad company, has, together with his engineer, examined the accompanying blue print. He agrees to the line recommended by me instead of the changed line asked for by him, and so authorizes me to state.

CHAS. F. POWELL,
Major, Corps of Engineers

[Fourth indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
September 14, 1900.

Respectfully returned to the Secretary of War.

The Pittsburg and Western Railway Company requests a modification of the established harbor line in front of its property, on the right bank of the Ohio River, in Allegheny City, Pa.

The subject has been under consideration by Maj. Chas. F. Powell, Corps of Engineers, who expresses the opinion in third indorsement hereon, that a change in the existing harbor line at this locality would be advantageous in that it would better preserve and protect the harbor. He accordingly recommends that the line be modified as shown in yellow on the accompanying blue prints. The modification recommended by him is stated to be satisfactory to the railroad company and to all other abutting property owners.

I recommend that the modification be approved, and that the Secretary place his approval on each of the three blue prints, which have been prepared for his signature.

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

[Fifth indorsement.]

WAR DEPARTMENT,
September 17, 1900.

Approved as recommended by the Chief of Engineers.

G. D. MEIKLEJOHN,
Acting Secretary of War.

APPENDIX I I.

IMPROVEMENT OF MUSKINGUM RIVER, OHIO, AND OF CERTAIN RIVERS IN WEST VIRGINIA AND KENTUCKY TRIBUTARY TO OHIO RIVER.

REPORT FOR THE FISCAL YEAR ENDING JUNE 30, 1901, WITH OTHER DOCUMENTS RELATING TO THE WORKS. OFFICERS IN CHARGE, MAJ. H. F. HODGES AND MAJ. E. H. RUFFNER, CORPS OF ENGINEERS.

IMPROVEMENTS.

1. Muskingum River, Ohio.
2. Operating and care of locks and dams on Muskingum River, Ohio.
3. Little Kanawha River, West Virginia.
4. Operating and care of lock and dam on Little Kanawha River, West Virginia.
5. Kanawha River, West Virginia.
6. Operating and care of locks and dams on Kanawha River, West Virginia.
7. Elk River, West Virginia.
8. Gauley River, West Virginia.
9. Guyandot River, West Virginia.
10. Big Sandy River, West Virginia and Kentucky.
11. Operating and care of lock and dam on Big Sandy River, West Virginia and Kentucky.
12. Tug Fork of Big Sandy River, West Virginia and Kentucky.
13. Levisa Fork of Big Sandy River, Kentucky.
14. Kentucky River, Kentucky.
15. Operating and care of locks and dams on Kentucky River, Kentucky.

SURVEY.

16. Big Sandy River, Kentucky and West Virginia, including Levisa and Tug forks.

ENGINEER OFFICE, U. S. ARMY,
Cincinnati, Ohio, July 15, 1901.

GENERAL: I have the honor to transmit herewith the annual reports of the works under my charge for the fiscal year ending June 30, 1901:

I took charge of the works on April 30, 1901, relieving Capt. (now Maj.) H. F. Hodges, Corps of Engineers.

The reports for the Kanawha, Elk, and Gauley rivers have been prepared by Asst. Engineer Addison M. Scott, in local charge.

The reports for the Little Kanawha and Muskingum rivers have been prepared by Asst. Engineer Edmund Moeser.

The reports for the Guyandot and Big Sandy rivers have been prepared by Asst. Engineer B. F. Thomas.

The reports for the Kentucky River have been prepared by Asst. Engineer John M. G. Watt.

Very respectfully, your obedient servant,

E. H. RUFFNER,
Major, Corps of Engineers.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

I I 1.

IMPROVEMENT OF MUSKINGUM RIVER, OHIO.

The authorized project for this work will be found in the summary. At the close of the fiscal year all work under it had been finished.

The only work carried on during the past year under this appropriation has been for laying a concrete pavement, 800 square feet in area, on the grounds belonging to the United States at Lock No. 1 (Ice Harbor Lock), of the Muskingum River system, and placing the necessary hand rails on the outside steps of the new lock house at this lock.

In the Annual Report of the Chief of Engineers for 1899, page 2454, an estimate of $8,000 for building five houses for lock tenders was submitted, and in the same report, page 424, the Chief of Engineers recommended further appropriation of $6,000 for raising the crests of Dams 3 and 9. For the reasons stated in the reports cited, the additional appropriation of $14,000 for these two items is recommended.

Commercial statistics are reported under the head of operating and care, etc.

Money statement.

July 1, 1900, balance unexpended	$1,184.19
June 30, 1901, amount expended during fiscal year	116.70
July 1, 1901, balance unexpended	1,067.49
July 1, 1901, outstanding liabilities	2.25
July 1, 1901, balance available	1,065.24
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901 Submitted in compliance with requirements of sundry civil act of June 4, 1897.	14,000.00

The following is a statement of the amount and dates of all appropriations and allotments for this work:

Act of August 11, 1888	$102,000
Act of July 1, 1898	6,000

I I 2.

OPERATING AND CARE OF LOCKS AND DAMS ON MUSKINGUM RIVER, OHIO.

A statement of the extent, original cost, etc., of the works embraced under this title is given in the summary of this report.

During the year ending June 30, 1901, the locks and dams have been kept in operation and repair, and four of the lateral canals, aggregating 2½ miles in length, have been maintained in navigable condition. The canal at Taylorsville, 1 mile in length, which is not now required for navigation, has been kept open to furnish water power.

Navigation was suspended at the locks for a total of thirty-seven days on account of ice.

Permits for work by private persons and corporations have been granted by the Secretary of War during the year, as follows:

At Marietta, Ohio.—To the Marietta Fuel Gas Company, permission, dated May 13, 1901, to lay a 6-inch pipe line across Muskingum River below Dam No. 1. Nothing was done.

At Lowell, Ohio.—To the commissioners of Washington County, Ohio, permission, dated May 28, 1901, to construct drawbridge across the head of canal. Nothing was done.

To Archer & Barry, Caldwell, Ohio, permission, dated August 16, 1900, to lay certain pipe lines across the canal. Nothing was done.

Between Lowell and Beverly, Ohio.—To A. J. Brown, Marietta, Ohio, permission, dated March 16, 1901, to lay certain pipe lines across the Muskingum River and Canal at Lowell. Nothing has been done.

At McConnelsville, Ohio.—To the Home Telephone Company, revocable license, dated April 8, 1901, to extend telephone line through the Government line. The line is in place.

At McConnelsville, Ohio.—To the commissioners of Morgan County, Ohio, permission, dated May 29, 1901, to reconstruct a bridge across Muskingum River. About one-half of the substructure has been reconstructed.

At Zanesville, Ohio.—To the Berlin Iron Bridge Company, Berlin, Conn., revocable license, dated November 26, 1900, to construct a temporary roadway on the slope of the canal bank. The roadway is in place.

To the Great Southern Gas and Oil Company, permission, dated October 9, 1900, to lay certain pipe line across the canal. Nothing was done.

To the commissioners of Muskingum County, Ohio, permission, dated August 18, 1900, to reconstruct a bridge over the Muskingum River at Main street. Work has been in progress, but is not finished.

Leases have been issued as follows:

To the Ohio and Little Kanawha Railroad Company, for 0.42 acre of land in the vicinity of Dam No. 7; to the McConnelsville-Malta Electric Company, for about 0.40 acre land at Dam No. 7, with the right to use 10,000 cubic feet of water per minute; to the village of Beverly, Ohio, for 0.40 acre land at Lock No. 4, with the right to use 5,000 cubic feet of water per minute.

The following is a summary of the work, in addition to the ordinary maneuvering of the locks and care of property, which was done at the different parts of the system during the last year:

At Lock No. 1, Marietta.—Refilled and revetted with concrete the eroded bank of raceway back of lock for a distance of 25 feet. Repairs were made in the raceway with the view to lessening the danger from leakage under the floor of lock, which has been a constant menace to the structure since 1896. The work accomplished consisted in excavating mud and trash in the head of race and back filling with 795 yards sand, gravel, and broken stone, after filling cavities underneath the lock with tight material. A concrete core wall, 20 feet in length, was built in under the upper face of the cross wall in raceway, and the areas immediately above and below cross wall were repaved.

At Lock No. 2, Devols.—Renewed the decayed timbers in the guide crib above lock and made temporary repairs to lock house.

At Lock No. 3, Lowell.—Made extensive repairs to the dam for 240 feet of its length. Repaired the lower gates of lock.

At Lock No. 4, Beverly.—Rebuilt two guide cribs above lock. Constructed an embankment across the lower end of the raceway to forestall damage from floods. Made minor repairs to embankments, lock irons, and machinery.

At Lock No. 5, Luke Chute.—Rebuilt guide crib above lock, 100 feet in length. Replaced two decayed arms on upper gates.

At Lock No. 6, Stockport.—Received and stored material for repairs of wall at right abutment, the completion of which had to be deferred on account of high water. Repaired guide crib at lock. Repaired and renovated the lock house.

At Lock No. 7, McConnelsville.—Reconstructed the old dam for 160 feet of its length. Renewed the floor and repainted the drawbridge over canal. Minor repairs were made to the abutments and guard gates at head of canal.

At Lock No. 8, Eagleport.—Refilled and backed part of dam with stone and gravel. Filled derrick stone along front of dam where scour had taken place. Replaced decayed blocks between arms of lock gates.

At Lock No. 9, Taylorsville.—Rebuilt the lower steps of the dam for 138 feet, and the second step for 176 feet. Employed labor to assist in placing splash boards on dam to afford a sufficient depth in pool above. Refilled and revetted 140 feet of canal bank. Replaced decayed parts of the lock gates and repaired lock machinery. Rebuilt one gate of the old lock used for docking purposes.

At Lock No. 10, Zanesville.—Replaced two decayed arms on guard gates. Received materials for repair of slope wall in canal and an abutment of the dam, the completion of which was deferred on account of high water.

The dredge was placed on the dry dock and the entire hull was rebuilt. One quarter boat, two dump scows, and one barge were pulled out and their hulls repaired and recalked.

The U. S. dredge *Malta* was employed throughout the working season in dredging out canals and shoals, in removing obstructions and rebacking dams. The operations extended over a distance of 11,760 feet. The dredge was attended by the hired steamer *Hazel Rice* and the U. S. steamer *Vega*, when the latter was not otherwise employed.

The work was under the local charge of Mr. Edmund Moeser, resident engineer.

The following is a statement of amounts and dates of all allotments for this work:

August 5, 1886 (appropriated)	$20,000.00
July 21, 1887 (allotted)	190,000.00
August 13, 1888 (allotted)	177,623.00
July 1, 1889 (allotted)	232,080.00
July 19, 1890 (allotted)	195,665.00
May 28, 1891 (allotted)	20,000.00
July 8, 1891 (allotted)	155,200.00
November 9, 1891 (allotted)	39,980.00
November 24, 1891 (allotted)	1,200.00
December 9, 1891 (allotted)	1,200.00
January 5, 1892 (allotted)	12,241.54
August 3, 1892 (allotted)	42,919.47
July 22, 1893 (allotted)	52,745.36
July 25, 1894 (allotted)	47,157.66
July 12, 1895 (allotted)	29,971.20
July 24, 1896 (allotted)	41,337.10
July 23, 1897 (allotted)	43,527.50
July 23, 1898 (allotted)	35,950.58
July 25, 1899 (allotted)	44,954.30
October 16, 1899 (allotted)	1,500.00
July 14, 1900 (allotted)	44,921.96
Total	1,430,174.67

Special work authorized by act of Congress.

March 21, 1895 (allotted), protection wall at Zanesville	$1,651.00
June 17, 1895 (allotted), pier of railroad bridge at Marietta	10,449.60
June 17, 1895 (allotted), pier of county bridge at Taylorsville	5,834.20
Total	17,934.80

ABSTRACTS OF CONTRACTS IN FORCE ON MUSKINGUM RIVER JUNE 30, 1901.

Contract for the construction of one wooden-hull, stern-wheel towboat, with machinery, complete, for use on the Muskingum River, Ohio.

Contractor.	Character of work.	Contract price.	Date of—		
			Approval.	Beginning.	Expiration.
Ed. J. Howard	One wooden-hull, stern-wheel towboat, with machinery, complete.	$9,805	Apr. 17, 1901	On or before May 10, 1901.	Aug. 10, 1901

Contract for hire of towboat to act as tender to U. S. dredge Malta during dredging season of fiscal year beginning July 1, 1901.

Contractor.	Character of work.	Contract price.	Date of—		
			Approval.	Beginning.	Expiration.
Muskingum and Ohio River Transportation Co.	Furnishing the services of steamer Hazel Rice and crew. Furnishing meals to Government employees when traveling on boat on official business.	$24 per day. 50 cents per meal.	June 27, 1901	When ordered.	Right reserved to discharge boat when funds are exhausted or when there is no further necessity for the continuation of dredging.

Summary of expenditures for operating and care of locks and dams on Muskingum River, Ohio, for the fiscal year ending June 30, 1901.

Office expenses, superintendence, and contingencies	$4,765.00
Labor	18,445.94
Fuel	340.50
Expenses	5,165.43
Repairs	6,430.96
Total	35,147.83

Detailed statement and cost of dredging on Muskingum River, under the appropriation for operating and care of canals and other works of navigation, indefinite, for the fiscal year ending June 30, 1901.

Date.	Locality.	Material excavated.	Total cost.
1900.			
July	McConnelsville, Ohio	2,498 yards mud, at 8 cents	$199.44
	Stockport, Ohio	300 yards gravel, at 15 cents	45.00
	Lowell, Ohio	10,350 yards mud, at 8 cents	828.00
	.....do	580 yards gravel, at 15 cents	87.00
August	.....do	8,000 yards sand and mud, at 8 cents	640.00
	Luke Chute, Ohio	2,672 yards gravel and mud, at 12.5 cents	334.00
	McConnelsville, Ohio	400 yards mud, at 9 cents	36.00
	Pool No. 8	3 snags, at $7.99	23.97
	Taylorsville, Ohio	900 yards mud, at 8 cents	72.00
September		Repairs	578.86
October		.....do	758.09
November	Taylorsville, Ohio	10,400 yards sand and gravel, at 9 cents	936.00
	.....do	120 yards stone, at 20 cents	24.00
	.....do	5 logs, at 50 cents	2.50
	.....do	7 snags, per lot	26.94
	.....do	25 yards mud, at 10 cents	2.50
	Zanesville, Ohio	2,730 yards mud, at 8 cents	218.40
December	.....do	8,220 yards mud, at 10 cents	822.00
December to May, 1901.		Repairs	1,514.69
1901.			
May	Zanesville, Ohio	5,365 yards mud, at 5 cents	268.25
June	.....do	6,522 yards mud, at 5 cents	326.10
	Lowell, Ohio	7,000 yards mud, at $9\frac{1}{15}$ cents	634.66
Total			8,378.40

Muskingum River leases.

Location.	Lessee.	Dated.	Expires.
Year ending April 30, 1901.			
Dam No. 1. Marietta	Phoenix Mill Co	May 1, 1873	May 1, 1908
Dam No. 2, Devols	Gates & Payne	May 1, 1889	May 1, 1909
Dam No. 3, Lowell	F. Wilking & Co	May 1, 1890	May 1, 1910
Do	Rechsteiner Bros	.....do	Do.
Do	.....do	Nov. 1, 1892	Nov. 1, 1912
Do	E. W. Sprague	Dec. 2, 1879	Dec. 15, 1909
Do	First National Bank	June 1, 1900	Do.
Do	E. W. Webster	.....do	June 1, 1906
Dam No. 4, Beverly	Robbins Bros	May 1, 1889	May 1, 1909
Do	Langenberg & Abrams	May 1, 1890	May 1, 1910
Do	Henry C. Baldwin	.....do	Do.
Do	D. T. Brown estate	.....do	Do.
Do	Isaac D. Spooner	.....do	Do.
Do	W. H. Matthew	.....do	Do.
Dam No. 6, Stockport	W. H. Phillips	May 1, 1889	May 1, 1909
Dam No. 7, McConnelsville	E. M. Stanbery	Sept. —, 1839	
Do	McConnelsville-Malta Electric Co	Nov. 1, 1900	Nov. 1, 1920
Do	Ohio and Little Kanawha R. R. Co	May 1, 1900	May 1, 1925
Dam No. 9, Duncans Falls	John Miller	Dec. 31, 1836	
Dam No. 9, Taylorsville	Frazier & Son	.....do	
Dam No. 10, Zanesville	John T. Drone	May 1, 1890	May 1, 1910
Do	Edward Johnson estate	.....do	Do.
Do	.....do	May 1, 1889	May 1, 1909
Do	Muskingum Coffin Co	May 1, 1890	May 1, 1910
Do	Zanesville Mantel and Furniture Co	.....do	Do.
Do	T. L. Moorehead	May 1, 1893	May 1, 1912
Do	Muskingum and Ohio River Transportation Co.	Nov. 13, 1897	Nov. 13, 1902
Symmes Creek	Jasper K. McCann	May 1, 1900	May 1, 1906
Year ending May 31, 1901.			
Dam No. 10, Zanesville	John Blankenbuhler	June 1, 1892	June 1, 1909
Do	Frederick Abel, estate	.....do	Do.

Leases—Water power, land, and rental.

Lessee.	Subject.	Cubic feet of water per minute.	Annual rental.	Rebate.	Rents collected.
Phoenix Mill Co	Water power	3,000	$350.00	$39.24	$310.76
Gates & Payne	do	9,000	108.00		108.00
F. Wilking & Co	do	7,280	174.72		174.72
Rechsteiner Bros	do	4,446	106.70		106.70
Do	Land		10.00		10.00
E. W. Sprague	do		5.00		5.00
First National Bank *a*	do		10.00		9.17
E. W. Webster *a*	do		5.00		4.58
Robbins Bros. *b*	Water power	1,904	100.00		
Langenberg & Abrams	do	5,600	114.24		114.24
Henry C. Baldwin *c*	do	5,000	100.00		100.00
D. T. Brown, estate *d*	do	6,033	109.80		109.80
Isaac D. Spooner *e*	do	4,000	100.00		42.50
W. H. Matthew *f*	do	4,000	100.00		6.10
W. J. Phillips	do	6,390	230.04		230.04
E. M. Stanbery *g*	do	(*h*)			
McConnelsville-Malta Electric Co. *i*	do	8,702	208.82		104.42
Ohio and Little Kanawha R. R. Co. *j*	Land		2.50		2.50
John Miller *g*	Water power	(*k*)			
Frazier & Son *g*	do	(*k*)			
John T. Drone	do	7,560	453.60		453.60
Edward Johnson estate *l*	do	6,029	361.74		361.74
do. *l*	do	7,399	443.82		443.82
Muskingum Coffin Co	do	4,619	207.86		207.86
Zanesville Mantel and Furniture Co	do	4,794	186.96		186.96
T. L. Moorehead	Land		25.00		25.00
Muskingum and Ohio River Transportation Co.	do		25.00		25.00
Jasper K. McCann *d*	do		5.00		5.00
John Blankenbuhler	Water power	2,700	100.00		100.00
Frederick Abel, estate	do	5,200	184.50		184.50
Total					3,332.01

a Leases issued commencing June 1, 1900.
b No collection.
c Lease canceled January 9, 1901; no collection.
d Lease transferred to T. F. Lowe April 10, 1901.
e Lease transferred to W. H. Matthew October 3, 1900.
f Lease canceled October 25, 1900.
g Perpetual free lease of water power.
h Enough to propel 10 run of 4 foot 5 inch millstones.
i Leases issued commencing November 1, 1900.
j Leases issued commencing May 1, 1900.
k Enough to propel 15 run of 4½-foot millstones.
l Leases transferred to W. J. Atwell, C. C. Atwell, and T. F. Spangler February 20, 1901.

COMMERCIAL STATISTICS.

Commerce of Muskingum River during the calendar year ending December 31, 1900.

LOCK NO. 1.

Month.	Steamboats.	Barges.	Miscellaneous.	Total.	Number of lockages.
January	30	10		40	32
February	10	2		12	10
March	43	12		55	43
April	62	33	39	134	75
May	40	17	18	75	50
June	53	21	28	102	62
July	38	21	2	61	47
August	16	11		27	21
September	2	5		7	7
October	2	7		9	5
November	14	10		24	16
December	38	20	2	60	43
Total	348	169	89	606	411

Commerce of Muskingum River, etc.—Continued.

LOCK NO. 2.

Month.	Steamboats.	Barges.	Miscellaneous.	Total.	Number of lockages.
January	29	3	....	32	32
February	27	2	....	29	29
March	57	6	....	63	63
April	57	11	....	68	68
May	65	12	2	79	79
June	65	8	....	73	73
July	59	6	....	65	65
August	77	8	....	85	85
September	67	4	....	71	70
October	64	3	1	68	68
November	55	2	....	57	57
December	64	7	....	71	71
Total	686	72	3	761	760

LOCK NO. 3.

January	30	4	....	34	33
February	26	2	2	30	30
March	57	6	....	63	63
April	59	11	....	70	68
May	63	6	3	72	72
June	63	3	2	68	68
July	46	2	4	52	52
August	76	6	1	83	83
September	61	3	2	66	66
October	63	2	....	65	65
November	55	2	....	57	57
December	65	4	....	69	69
Total	664	51	14	729	726

LOCK NO. 4.

January	31	3	....	34	34
February	26	4	2	32	32
March	56	7	1	64	64
April	57	4	....	61	60
May	63	....	....	63	63
June	63	6	....	69	65
July	52	8	2	62	62
August	67	16	3	86	86
September	65	13	....	78	66
October	59	8	2	69	65
November	59	7	....	66	59
December	62	4	4	70	66
Total	660	80	14	754	722

LOCK NO. 5.

January	7	1	1	9	9
February	4	2	1	7	7
March	11	4	5	20	20
April	11	2	....	13	13
May	9	....	1	10	10
June	15	2	1	18	18
July	17	6	3	26	25
August	17	9	16	42	36
September	21	11	2	34	28
October	38	4	3	45	40
November	29	10	1	40	30
December	16	2	1	19	19
Total	195	53	35	283	255

Commerce of Muskingum River, etc.—Continued.

LOCK NO. 6.

Month.	Steamboats.	Barges.	Miscellaneous.	Total.	Number of lockages.
January	7	1	....	8	8
February	4	2	1	7	7
March	9	4	....	13	18
April	9	2	....	11	11
May	9	....	....	19	18
June	12	6	2	20	18
July	17	5	12	34	30
August	10	7	27	44	30
September	19	5	2	26	23
October	34	5	6	45	38
November	59	7	2	35	27
December	17	3	5	25	22
Total	173	47	67	287	245

LOCK NO. 7.

Month.	Steamboats.	Barges.	Miscellaneous.	Total.	Number of lockages.
January	3	2	....	5	5
February	1	2	....	3	8
March	4	4	....	8	8
April	5	4	....	9	9
May	10	1	....	11	11
June	14	4	....	18	16
July	17	9	4	30	26
August	12	18	17	47	36
September	21	9	11	41	33
October	36	4	2	42	38
November	25	8	....	33	26
December	14	2	2	18	16
Total	162	67	36	265	227

LOCK NO. 8.

Month.	Steamboats.	Barges.	Miscellaneous.	Total.	Number of lockages.
January	50	....	....	50	50
February	51	....	....	51	51
March	104	....	2	106	106
April	110	....	5	115	115
May	121	4	2	127	127
June	127	2	12	141	137
July	135	6	6	147	144
August	140	4	12	156	148
September	131	14	10	155	152
October	173	35	6	214	201
November	126	11	4	141	134
December	112	3	....	115	115
Total	1,380	79	59	1,518	1,480

LOCK NO. 9.

Month.	Steamboats.	Barges.	Miscellaneous.	Total.	Number of lockages.
January	58	....	....	58	58
February	58	....	....	58	58
March	108	....	....	108	108
April	109	2	....	111	110
May	126	....	8	134	133
June	137	4	12	153	153
July	139	2	4	145	143
August	149	8	8	165	155
September	133	7	3	143	132
October	161	18	7	186	176
November	130	12	5	147	145
December	114	5	....	119	119
Total	1,412	58	47	1,517	1,480

Commerce of Muskingum River, etc.—Continued.

LOCK NO. 10.

Month.	Steamboats.	Barges.	Miscellaneous.	Total.	Number of lockages.
January	52	....	....	52	52
February	51	....	....	51	51
March	108	2	....	110	110
April	110	1	1	112	111
May	119	2	2	123	123
June	226	85	2	313	235
July	136	2	1	139	139
August	156	3	2	161	159
September	114	3	2	119	119
October	139	9	....	148	144
November	116	28	....	144	144
December	108	197	....	305	303
Total	1,435	332	10	1,777	1,690

SUMMARY.

Lock No.	Steamboats.	Barges.	Miscellaneous.	Total.	Number of lockages.
1	348	169	89	606	411
2	686	72	3	761	760
3	664	51	14	729	726
4	660	80	14	754	722
5	195	53	35	283	255
6	173	47	67	287	245
7	162	67	36	265	227
8	1,380	79	59	1,518	1,480
9	1,412	58	47	1,517	1,480
10	1,435	332	10	1,777	1,690
Total	7,115	1,008	374	8,497	7,996

Statement of commerce passing the locks on the Muskingum River, Ohio, during the calendar year ending December 31, 1900.

Articles.	Lock No.—									
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Beer ....tons..	22	27	32	16	12	13	15	46	63	91
Brick ....do...	40	137	128	120	55	115	105	570	590	570
Cattle ....do...	397	391	353	307	217	180	117	156	109	139
Coal ....do...	4,670	1,290	1,473	1,020	610	460	270	1,787	900	850
Corn ....do...	316	360	456	486	188	236	167	516	509	666
Cement ....do...	8	51	44	31	11	19	36	239	237	204
Eggs ....do...	566	465	459	418	277	199	275	142	136	146
Flour ....do...	646	904	890	952	298	343	232	253	283	203
Hay ....do...	582	704	666	695	487	308	286	687	730	787
Hides ....do...	8	3	3	1	1	1	1	14	14	14
Hogs ....do...	181	186	187	174	113	90	59	60	50	58
Horses ....do...	233	246	274	243	233	255	154	177	170	208
Iron ....do...	1,152	1,264	1,240	1,150	788	688	618	718	741	791
Leather ....do...	....	....	....	....	....	....	....	12	12	12
Lumber ....do...	5,134	706	578	618	240	340	376	643	672	645
Lime ....do...	2	51	37	29	3	9	27	215	290	253
Merchandise, miscellaneous ....tons..	8,178	19,054	11,517	15,514	7,814	6,624	5,083	20,691	23,829	36,540
Molasses ....do...	....	....	....	....	....	....	....	2	2	....
Oil ....do...	36	67	63	51	14	12	20	101	111	127
Produce ....do...	3	49	64	39	....	....	....	1	1	....
Poultry ....do...	458	503	473	391	337	363	212	57	46	53
Salt ....do...	268	268	226	199	212	137	94	496	433	470
Stoneware ....do...	452	504	437	444	424	409	413	454	534	397
Straw ....do...	627	534	592	635	386	302	135	704	750	841
Staves ....do...	115	115	166	115	100	45	44	....	....	....
Sugar ....do...	4	9	....	....	....	3	10	283	302	366
Sheep ....do...	76	52	44	41	15	16	3	5	5	5
Sand, stone, etc. do...	401	961	987	1,009	385	473	514	726	....	13,893
Shingles ....do...	....	....	8	....	15	....	....	15	15	....
Ties, railroad ...do...	....	200	....	....	....	....	....	....	....	....
Tallow ....do...	....	....	....	....	....	1	1	2	2	....
Wheat ....do...	234	273	399	592	331	322	375	711	732	882
Whisky ....do...	....	....	....	....	....	....	2	6	6	6
Wool ....do...	....	....	....	....	....	....	....	4	4	4
Total	24,809	29,374	21,796	25,280	13,516	11,963	9,644	30,443	31,769	49,221
Passengers .number..	9,629	22,733	17,198	12,057	2,599	2,520	2,857	41,164	71,109	93,866

List of steamboats (stern-wheel) plying on the Muskingum River between Zanesville and Marietta, Ohio.

Name of steamer.	Length.	Breadth.	Depth.	Draft.	Tonnage.
	Feet.	*Feet.*	*Feet.*	*Inches.*	
Lorena	141	32	5	24	287
Hazel Rice	126	22½	4	26	138
Sonoma	125	20	3½	23	116
Jewel	116	26	3¾	24	95
Valley Gem	125	26½	4	24	156
Zanetta *a*	150	35	6	33	165
Del Norte	35½	8½	4⅝	40	5
U. S. Vega *b*	75	12	3½	30	30
Nellie Bartlett	95⁹⁄₁₆	14	3⁴⁄₁₆	24	56.18
Hawk *c*	118	20	4	38	141
Lula F. *c*	98	15	2½	20	37
Adelle *c*	130½	23	3½	40	134
D. T. Watson *c*	99	17	2½	24	80
Vulcan *c*	135	24	4	40	140
Darling *c*	100	22⁷⁄₁₂	3½	32	79
Catharine Davis *c*	135½	27	3½	22	210
Francis J. Torrence *c*	211⁵⁄₁₂	34¾	6½	42	667
J. B. Finley *c*	209⅝	42⅝	7	56	679
F. A. Gobel *c*	100	16	3⁵⁄₁₆	22	75
Venus *c*	90	14	2⁹⁄₁₆	20	56
Katie *c*	95	16	3	18	75
Dispatch *c*	90	25	3	18	80
City of Wheeling *c*	110	34	4½	26	150

a Side-wheel. *b* Propeller. *c* Only occasional trips on Muskingum River.

I I 3.

IMPROVEMENT OF LITTLE KANAWHA RIVER, WEST VIRGINIA.

A description of the original condition of the river and the adopted project for its improvement will be found in the Annual Report of the Chief of Engineers for 1900, page 489.

Nothing was done during the fiscal year ending June 30, 1901, as the balance unexpended would not suffice to prepare for and prosecute the required operations.

The project adopted in 1877 is to remove such obstructions as rocks, snags, overhanging trees, etc., from the stream above Burning Springs, W. Va., about 40 miles above Parkersburg, so as to aid light-draft steamboat navigation and the floating of timber to market. To continue this improvement will require $1,500 in addition to the funds remaining on hand July 1, 1901.

The commerce is reported under the head of "Operating and care of Lock and Dam No. 5, on Little Kanawha River."

Money statement.

July 1, 1900, balance unexpended	$171.74
July 1, 1901, balance unexpended	171.74
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement, in addition to the balance unexpended July 1, 1901	[1] 1,500.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

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[1] Exclusive of amount required for operating and care of lock and dam.

The following is a statement of the amounts and dates of all appropriations:

August 14, 1876	$7,300	August 11, 1888	$25,000
June 18, 1878	18,000	September 19, 1890	40,000
March 3, 1879	18,000	June 3, 1896	1,500
June 14, 1880	15,000	March 3, 1899	743
March 3, 1881	40,000		
August 2, 1882	31,000	Total	213,418
August 5, 1886	16,875		

I I 4.

OPERATING AND CARE OF LOCK AND DAM ON LITTLE KANAWHA RIVER, WEST VIRGINIA.

This lock and dam, known as No. 5, is located 41 miles from the mouth of the river, and was opened to navigation December 2, 1891.

Below Lock No. 5 there are four locks and dams, owned and operated by the Little Kanawha Navigation Company. The leaky condition of these dams frequently stops navigation below Dam No. 5.

During the past year navigation was suspended through the lock for eighty days on account of low water, for six days on account of ice, and for seven days on account of floods which drowned out the lock.

The stated repair project in the approved estimate for the year ending June 30, 1901, consisted in rebuilding a guide crib above the lock (about 100 feet in length), refastening two of the lock-valve stems, repairing certain parts of the lock masonry, paving part of the terreplein, placing a stone covering over the eroded bank at abutment of dam, and repairing the waiting room and storehouse. This work, as well as certain unforeseen repairs to valves, lock gates, and grounds at lock, has been finished, and the lock, dam, and appurtenances have been operated and cared for. The total expense has been $2,520.84, including outstanding liabilities, June 30, 1901.

The work has been under the local charge of Mr. Edmund Moeser, resident engineer.

The following is a statement of all allotments for the work:

November 28, 1891	$1,500.00	July 23, 1897	$1,684.03
July 15, 1892	4,426.65	August 3, 1898	3,038.53
July 21, 1893	3,837.97	July 21, 1899	2,331.58
July 16, 1894	3,491.03	July 14, 1900	2,271.61
July 20, 1895	3,378.17		
July 24, 1896	830.72	Total	26,790.29

Summary of expenditures for operating and care of lock and dam on Little Kanawha River, West Virginia, for the fiscal year ending June 30, 1901.

Office expenses, superintendence, and contingencies	$295.00
Labor	1,372.60
Fuel	13.00
Expenses	161.43
Repairs	513.60
Total	2,355.63

COMMERCIAL STATISTICS.

Statement of commerce passing Lock No. 5, Little Kanawha River, West Virginia, during the calendar year ending December 31, 1900.

Articles.	Amount.	Articles.	Amount.
Beer tons	32	Lumber tons	910
Beans do	7	Lampblack do	8
Carbon do	2	Merchandise, miscellaneous do	3,018
Cement do	9	Oil do	77
Coal do	1,600	Poultry do	15
Corn do	226	Salt do	96
Cross-ties do	540	Sugar do	63
Eggs do	20	Stoneware do	13
Flour do	536	Staves do	800
Furs do	1	Telephone poles do	729
Hay do	241	Ties, railroad do	21,689
Hides do	5	Timber do	81,417
Horses do	1	Whisky do	1
Hoop poles do	1,575		
Iron, manufactured do	563	Total	119,439
Junk do	25		
Logs do	5,220	Passengers	6,680

The total freight of 119,439 tons is valued approximately at $1,669,402.

List of steamboats plying on Little Kanawha River, West Virginia.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
Kathryn	Stern wheel	105	22.5	3.6	67.54
Darling	do	100	22.7	3.6	78.80
Burnadina King	do	90	18	3.5	106
D. T. Watson	do	90	17	2.6	80.45
Mary E	do	86	13.6	3.6	19.34
Lula F	do	98.4	15.1	2.6	87.16
Nellie Bartlett	do	95.8	14	3.4	56.18
Telephone	do	93	16	2.6	73
Oneida	do	104	19.5	4.2	75.78

Boats operating in upper river, propelled by gasoline engines, between Creston and Grantsville, W. Va.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
Yukon	Stern wheel	80	7.5	1.7	10
Clipper	do	75	8	1.7	10
Calhoun	do	70	8	2	10
Mabel B	do	80	7.5	1.7	10
Edith H	do	60	9	2	12
Creston	do	65	9	2.4	12
A. C. Barney	do	75	10	2	12
Hurrican	do	65	7.5	1.8	10

Report of lockages on the Little Kanawha River, West Virginia, for the calendar year ending December 31, 1900.

LOCK NO. 5.

Month.	Steamboats.	Barges and flats.	Rafts.	Miscellaneous.	Number of lockages.
January	62	6	140	2	210
February	78	14	182	4	228
March	118	22	650	4	787
April	108	13	437		555
May	99	9	192	8	308
June	150	12	265	3	428
July	162	12	216	5	391
August	114	11	267	4	389
September	36	1		2	39
October					
November	46	10	45		101
December	101	13	411	3	528
Total	1,069	123	2,755	35	3,964

I I 5.

IMPROVEMENT OF KANAWHA RIVER, WEST VIRGINIA.

The original condition of the river, projects, and a summary of work done to June 30, 1900, are given in the Report of the Chief of Engineers for 1900, pages 490, 491, and 492.

The principal work done during the past year was in continuing the improvement of the towing channels in the pools by dredging and crane boat work, finishing lock houses, drilling wells and making cisterns for some of the lock houses, setting capstans on lock walls, and beginning the construction of a new towboat.

Operations with the dredge and crane boat on "original work" were, with the exception of 4 days at Knob Shoal (in No. 10 pool), confined to pools Nos. 3, 4, 5, and 6. The principal places worked on were as follows, viz: In the vicinity of Crown Hill and Belmont in No. 4 pool; between the head of Witchers Creek Shoal and Lock 4 in No. 5 pool; near the mouth of Rush Creek and at head of Island Shoal in No. 6 pool; and at Harveys Shoal in No. 3 pool. During the year 29,860 cubic yards of material were dredged and dumped. In connection with this dredging, and in addition thereto, 385 stone, aggregating about 285 cubic yards (found generally from 6 to 18 inches above miter-sill level), and 23 sunken trees and snags were removed from the new-made or improved channels mainly with the crane boat. The original dredging in the pools is with but little exception hard digging—mainly stone (many of them large) and coarse gravel, sometimes found "cemented." The cutting is all light, generally from 1 to 2 feet deep (to make miter-sill depth), and a great deal of ground has to be worked over for the quantity of material handled. A material improvement was made in the towing channels, particularly in pools 4 and 5, where the greater part of the work was done, by this work during the year. The remainder of work by the dredge and crane boat was on operating and care of locks and dams on the Kanawha River and is given in that report.

Four houses for lock hands, at Locks 3, 4, and 5, were built or finished, completing the contract with Neil & Hamm made last year. Three wells were drilled, one dug, and two cisterns made for the lock hands, and 10 additional hand-power capstans procured and set on lock walls for use in locking coal barges and rafts.

The building of the towboat referred to in the last annual report was awarded to Charles Ward, of Charleston, W. Va., by contract approved January 4, 1901. It is to be a steel-hulled, twin-screw boat; hull, 120 by 22 feet; draft not to exceed 32 inches. The engines, which are quadruple expansion, with cylinders 7, 10, 14, and 20 inches diameter, and common stroke of 12 inches, are now nearly completed. The materials for the hull have all been procured and a beginning made on its construction. As noted in the last annual report, one-half the cost of this boat is to be defrayed from funds available for improving the river and one-half from the permanent indefinite fund for operating and care of canals, etc. During the year a new fuel flat for the dredge was built under informal contract and some necessary repairs made on the dredge and scows.

Commercial statistics are given in report for operating and care of locks and dams, Kanawha River.

Money statement.

July 1, 1900, balance unexpended	$195,188.61
June 30, 1901, amount expended during fiscal year	12,434.66
July 1, 1901, balance unexpended	182,753.95
July 1, 1901, outstanding liabilities	748.85
July 1, 1901, balance available	182,005.10
July 1, 1901, amount covered by uncompleted contracts	14,000.00

APPROPRIATIONS.

March 3, 1873	$25,000	August 5, 1886	$187,500
June 23, 1874	25,000	August 11, 1888	350,000
March 3, 1875	300,000	September 19, 1890	300,000
August 14, 1876	270,000	July 13, 1892	225,000
June 18, 1878	222,000	March 3, 1893	500,000
March 3, 1879	150,000	March 2, 1895	580,700
June 14, 1880	200,000	June 4, 1897	273,000
March 3, 1881	200,000		
August 2, 1882	200,000	Total	4,208,200
July 5, 1884	200,000		

For abstract of contracts in force, see report for operating and care of locks and dams, Kanawha River.

I I 6.

OPERATING AND CARE OF LOCKS AND DAMS ON KANAWHA RIVER, WEST VIRGINIA.

The locks and dams on this stream, of which there are ten, two with fixed and eight with movable dams, were built from the appropriations for improving (Great) Kanahwa River. Their location and time of completion are given in the Annual Report of the Chief of Engineers for 1899, page 428. From time to time, as they have been opened to navigation, their maintenance has devolved upon the indefinite appropriation of July 5, 1884, for operating and care of canals and other works of navigation.

During the fiscal year ending June 30, 1901, the system has been operated and kept in repair. At the fixed dams (Nos. 2 and 3) navigation was interrupted eighteen and one-half days by high water, four days by ice, and ten days for repairs, the latter being only at Lock 3, as noted below.

The movable dams were raised and lowered as required. They were raised and lowered from five to seven times during the year. The dams were operated without serious accident or delay, though much trouble was experienced at times with drift brought in from tributary streams where large lumbering operations are carried on. On the night of July 27 a boom broke in Pocatalico River (this stream comes in 2½ miles above Lock 8), caused by heavy rains and a sudden rise, and about 100,000 oak railroad ties, 8,000 saw logs, and a mass of drift were carried into the Kanawha. A large quantity of this lodged against the service bridge at Lock 8, but by prompt work and good management on the part of the lockmen the dam was all lowered, after several hours' delay, without damage. The dams below No. 8 were notified in time to get down out of the way. On November 24, when lowering Dam No. 11 for a rise in the river, a raft of about 5,000 railroad ties that was tied up alongshore above the lock broke loose and came down against the pass bridge. This was about 5 p. m., and it took until midnight to clear away the ties so the bridge could be put down. The only injury to the dam consisted in badly bending three of the trestles. These were afterwards taken out and straightened in the shop at the site.

The number of days each dam was kept up during the year was as follows: Dam No. 4, 195 days; Dam No. 5, 197; Dam No. 6, 166; Dam No. 7, 166; Dam No. 8, 163; Dam No. 9, 155; Dam No. 10, 157; Dam No. 11, 156 days. The rest of the time the dams were down on account of high or sufficient water or ice. The total days the dams were kept up was below the average, owing to an unusual amount of high water in May and June.

As usual, a good deal was done, mainly by the regular lock hands, in keeping the works in repair and order. In addition to ordinary work of this kind, the following items of repairs are noted: At Lock No. 2 the land guide crib at the foot of the lock was taken down and rebuilt from pool level up, and some repairs made on the upper guide cribs; about 15,000 feet B. M. of new oak lumber was used in these repairs. High water in December undermined a part of the retaining crib below the abutment and made a bad break in the slope paving; 104 cubic yards of large "derrick" stone were hauled from the quarry at and boated from Lock 3 to repair the damage. At Lock 3 timber and irons were procured for a new set of upper gates for the lock; one of these gates has been built and hung and considerable done at framing and ironing the second leaf; in connection with taking down the old and raising the new gate, four of the filling valves were removed (by use of a diving outfit) and repaired; the outside guide crib at head of lock was taken down, the paving and stone filling removed, and rebuilt from pool level up; 23,520 feet of new timber was used in repairing this crib. At Lock 5 a new hull for the large service boat was procured; two rounds of new timber were put on the lower guide crib of the lock. At Lock No. 6 the damage done to the foot bridge of the weir on June 30, 1900, by logs and drift, described in the last annual report, was repaired at a cost, outside of work by the regular hands and Government boats, of $481.56; the outside crib at head of Lock 6 was partly rebuilt, about 6,000 feet of new timber being used. At Locks 7 and 8 new hulls were built for the small service boats. In addition to repairs noted, 14 new wickets were built and 216 wickets and 17 bridge trestles repaired at the different movable dams. Except the service boat hull at Lock 5, and a part of the repairs to the No. 6 foot bridge, all of the building and repairs noted above were done at the different sites by the regular hands, assisted when necessary by extra hired labor.

The dredge, crane boat, and towboat were employed as required in removing deposit, snags, etc., from the lock chambers and approaches and from channels in the pools. In all, 10,920 cubic yards of material were dredged and dumped and 41 snags and trees and 2 wrecks removed. In addition, 6,260 cubic yards of heavy material, dredged on improving Kanawha River, were towed to and dumped back of fixed Dams Nos. 2 and 3 to fill scoured places in the banking. The boats and crews were employed 14 days in July in clearing Dam No. 6 of drift and assisting, as before noted, on the repairs there. The towboat, with the crane boat, was employed part of the time in May and June assisting in launching and raising the new gate, etc., at Lock 3. The greater part of the dredging and crane-boat work during the year was on improving Kanawha River and is given in that report.

The Government telephone line which extends from Kanawha Falls to Lock No. 11, a distance of 93 miles, connecting with all the locks and the central office at Charleston, was kept in repair. In addition to ordinary work and repairs on the line, 110 new poles and about 8 miles of new wire were put up during the year. The repairs to the line are made by the regular lock hands, assisted occasionally by some hired labor.

The total expenditure for the year has been $61,145.31, including outstanding liabilities June 30, 1901.

The following is a statement of the amounts and dates of allotments for this work:

———	$7,075.00
———	7,810.00
July 8, 1886	11,170.00
June 17, 1887	13,289.00
February 4, 1888	3,549.70
August 16, 1888	19,990.02
July 11, 1889	20,600.00
July 16, 1890	25,702.27
October 9, 1890	3,400.00
July 14, 1891	19,453.00
July 6, 1892	21,891.64
July 12, 1893	24,549.41
July 10, 1894	$30,600.00
July 2, 1895	30,200.00
July 25, 1896	37,082.59
August 2, 1897	22,700.77
July 26, 1898	36,331.90
September 29, 1898	2,650.00
June 2, 1899	14,000.00
August 2, 1899	36,416.13
April 10, 1900	1,400.00
July 13, 1900	49,444.47
Total	439,305.90

ABSTRACT OF CONTRACT IN FORCE ON KANAWHA RIVER JUNE 30, 1901.

Contract for constructing one steel-hulled twin-screw towboat for use on the Kanawha River, West Virginia.

Name of contractor.	Character of work.	Contract price.	Date of—		
			Approval.	Beginning.	Expiration.
Charles Ward	1 steel-hulled twin-screw towboat.	$28,000	Jan. 4, 1901	On or before Jan. 29, 1901.	Dec. 9, 1901

Summary of expenditures for operating and care of locks and dams on Kanawha River, West Virginia, for the fiscal year ending June 30, 1901.

Office expenses, superintendence, and contingencies	$5,912.16
Labor	29,005.80
Fuel	412.11
Expenses	2,807.68
Repairs	6,019.28
Total	44,157.03

COMMERCIAL STATISTICS OF THE KANAWHA RIVER, WEST VIRGINIA.

Statement of number of tons of coal, including that manufactured into coke, shipped by river from mines on the Kanawha (below Kanawha Falls) for the several years named.

	Tons.		Tons.		Tons.
Fiscal year—		Fiscal year—		Fiscal year—	
1875	161,932	1887	929,335	1895	879,304
1876	200,962	1888	804,025	1896	922,000
1877	207,346	1889	1,076,872	1897	848,600
1881	385,148	1890	966,462	Calendar year—	
1883	614,818	1891	1,030,454	1897	650,680
1884	736,843	1892	1,071,511	1898	1,089,160
1885	712,493	1893	919,320	1899	942,800
1886	714,465	1894	1,032,840	1900	1,240,680

Tonnage of the Kanawha River for the calendar year ending December 31, 1900.

Articles.		Quantity.	Tonnage.
Coal	bushels	31,017,000	1,240,680
Timber	feet B. M.	29,460,000	49,100
Staves, oak	number	851,000	6,382
Bark and wood for tanning	cords	3,947	7,696
Hoop poles	number	612,600	1,530
Lath	do	2,153,900	430
Railroad ties, oak	do	786,700	110,303
Shingles	do	1,233,000	185
Brick	do	288,000	720
Salt	barrels	8,300	1,162
Merchandise and produce in steamboats	tons	....	57,742
Total		....	1,475,930

Total tonnage of the Kanawha River for the several years named.

	Tons.		Tons.		Tons.
Year ending June 30—		Year ending June 30—		Calendar year—	
				1897	832,002
1890	1,127,232	1894	1,222,530	1898	1,244,334
1891	1,225,355	1895	1,082,342	1899	1,124,364
1892	1,360,750	1896	1,162,782	1900	1,475,930
1893	1,116,587	1897	1,124,843		

Commerce passing each of the ten locks and dams in Kanawha River, West Virginia, during the calendar year ending December 31, 1900.

Articles.		Lock No. 2.	Lock No. 3.	Lock No. 4.	Lock No. 5.	Lock No. 6.
Coal	bushels	3,284,500	4,823,500	11,861,400	17,057,800	21,652,500
Coke	tons	4,000	4,000	4,000	4,000	4,000
Lumber, etc	feet	827,783	401,783	542,933	764,400	12,859,137
Shingles	number	404,000	425,000	638,500	823,750	54,000
Laths	do	....	....	80,700	89,000	823,000
Brick	do	43,800	43,850	91,800	123,450	85,420
Miscellaneous freight	tons	8,406	12,385	19,508	23,029	20,149
Steamboats	number	1,567	1,697	2,118	2,328	2,503
Coal barges	do	441	727	1,927	2,752	3,415
Other craft	do	97	61	104	133	71
Passengers	do	14,401	18,423	26,359	31,106	20,086
Salt	barrels	241	271	583	1,942	1,582
Railroad ties	number	4,500	3,000	8,000	7,500	84,910
Staves	do	51,000	100,000	100,000	100,000	239,000
Hoop poles	do	....	....	112,000	....	103,100
Bark	cords	....	....	....	....	135
Lockages made	number	1,719	1,960	1,661	1,891	1,678

Commerce passing each of the ten locks and dams in Kanawha River, West Virginia, etc.—Continued.

Articles.	Lock No. 7.	Lock No. 8.	Lock No. 9.	Lock No. 10.	Lock No. 11.
Coal ....bushels..	21,721,400	28,904,900	30,011,300	30,434,300	30,527,500
Coke ....tons..	4,000	4,000	4,000	4,000	4,000
Lumber, etc ....feet..	8,936,474	15,344,782	11,211,341	11,857,175	18,987,692
Shingles....number..	93,000	83,500	81,500	54,500	164,500
Laths ....do....	1,830,900	1,349,800	1,714,800	1,549,500	1,878,400
Brick ....do....	112,201	116,276	431,150	418,000	561,800
Miscellaneous freight....tons..	22,852	24,096	25,844	27,001	28,344
Steamboats ....number..	2,416	2,459	2,465	2,510	2,653
Coal barges....do....	3,406	4,220	4,764	4,818	4,996
Other craft....do....	142	133	142	170	188
Passengers....do....	21,656	20,209	18,285	19,848	25,898
Salt ....barrels..	1,463	1,481	1,868	2,362	2,699
Railroad ties....number..	126,962	383,830	495,522	612,582	786,750
Staves ....do....	375,350	539,000	637,850	851,030	552,500
Hoop poles....do....	171,758	142,500	186,700	335,800	612,670
Bark....cords..	135	100	36	36	36
Lockages made ....number..	1,605	1,825	1,711	1,836	1,816

List of steamboats plying the Kanawha River, West Virginia, for the calendar year 1900.

[All stern-wheel, except as noted.]

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
Kanawha	Packet	185	35	4	429.07
Lizzie Bay....	....do....	181	30.8	4	198
Henry M. Stanley	....do....	180	32.4	5.5	293.71
Greenwood....	....do....	165	32	4.5	270
Urania	....do....	160	28	5	213.09
Columbia....	....do....	156	24.2	4	197.96
Speedwell	....do....	140	25	4	149.40
Cricket	....do....	132	18	3	65
Argand....	....do....	130	24.8	4	96
Kanawha Belle	....do....	128	24.2	4	133.50
Cando	....do....	127	23	3.5	74
Lexington....	....do....	121	22.4	3.6	58
Baxter	....do....	121	22	3.5	75
Estola	....do....	120	20	3.5	110
Neva	....do....	117	21.6	3.4	71.48
Maxie Yost....	....do....	117	15	3.5	47
T. D. Dale....	....do....	111.6	19.7	3.2	85.77
Charlie Stone....	....do....	102	26	3.5	88
Henrietta	....do....	101	16	3.5	48
Venus	....do....	90	18	3.6	49
Sadie E....	....do....	50	8	2.5	8
Laura[a]....	....do....	57	10	3.5	9.60
Dauntless[a]....	....do....	52	9	4.5	13
Alice Brown....	Towboat	193	34	4	551
E. R. Andrews	....do....	165	32.5	5.2	351.07
Florence Marmet....	....do....	155	30	5	263
Otto Marmet	....do....	149.5	24	4.8	135.20
John Moran	....do....	148	27	4.5	284
Convoy....	....do....	146	26.5	3.7	170.53
Henry De Bus	....do....	143	28	5	193
William Ernst....	....do....	140	25.2	4	197.64
Eagle....	....do....	140	24.5	4.8	185
Relief	....do....	140	25	4	248
R. K. Wells	....do....	136	26.6	4	156
Catherine Davis....	....do....	135	26	4	334
Mount Clare....	....do....	134.5	25.8	4.8	191.36
Belle McGowan	....do....	134	22	4.5	150
John C. Fisher....	....do....	133	25	3.5	156
Adelle....	....do....	133	24	4	166
J. B. Lewis....	....do....	132	22	4.5	162
D. T. Lane	....do....	129.6	24.1	4	146.94
Crown Hill	....do....	127	19.5	4	120
G. W. Moredock	....do....	126.5	25.4	3.2	148.75
Gate City	....do....	125	25.7	4.5	109.44
Sea Lion....	....do....	121	20	3	106
John Mackey....	....do....	120	23.5	3.6	124.16
Jessie....	....do....	120	20	3.4	68.47
J. H. McConnell....	....do....	117.9	20	3.7	138
Annie L	....do....	115.8	20.3	3.1	114.69
Geo. Matheson	....do....	112	22	4	124.06
W. B. Calderwood....	....do....	112	24.5	4.6	85.55
Oneida	....do....	104.1	19.7	4	75

*List of steamboats plying the Kanawha River, West Virginia, for the calendar year 1900—*Continued.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
Darling	Towboat	102	22	4	78
Mary Stewart	do	100	20	3.2	91
Lulu F	do	98	15	2.5	51
Nellie England	do	92	18	3.5	85
W. O. Hughart	do	73	16	4	67
G. T. Thayer	do	49	9.3	2.2	7.95
Bee	United States towboat	120	22	3.6	85
Goldenrod	United States light-house tender.	150	26.5	3.7	143.58
Mascot *a*	United States launch	61	8.1	3.4	7
Troubador	Show boat	93.4	18	3	61.37
Little Lafie	Ferryboat	84	24	3	56
Whisper	do	75	20	3	83
Billy Martin *a*	Pump and harbor	89	14.3	4	28.15
Iron Duke *a*	do	88	13.5	3.7	30.60
Madge *a*	Launch	66.5	10.5	4	9.93
Nancy E. *a*	do	35	6	4	3
Lucy *a*	do	28.7	6	3	2
Ruth *a*	do	25	5	4	2
Amelia *a*	do	25	5	4	2
Soncy *a*	do	18	5	3	1

a Screw propellers.

I I 7.

IMPROVEMENT OF ELK RIVER, WEST VIRGINIA.

A description of the original condition, project, etc., is given in the report of the Chief of Engineers for 1900, pages 493–494.

Nothing was done on this stream during the year ending June 30, 1901.

No appropriation is asked for continuing the project.

Money statement.

June 1, 1900, balance unexpended	$253.13
July 1, 1901, balance unexpended	253.13
Amount (estimated) required for completion of existing project	69,000.00

APPROPRIATIONS.

June 18, 1878	$5,000	September 19, 1890	$2,500
June 14, 1880	5,000	July 13, 1892	2,500
March 3, 1881	5,000	August 18, 1894	2,000
August 2, 1882	2,000	June 3, 1896	2,000
August 5, 1886	1,500		
August 11, 1888	3,000	Total	30,500

COMMERCIAL STATISTICS FOR ELK RIVER, WEST VIRGINIA.

	Saw logs and lumber.	Railroad ties, oak.	Staves, oak.	Hoop poles.	Hickory spokes.	Tanbark and tanwood.	Tonnage of timber products.
Fiscal year—	*Feet B. M.*					*Cords.*	
1883	5,200,000	100,000	898,334	....	....	....	24,790
1884	5,975,000	125,000	1,122,500	....	....	....	30,700
1885	5,100,000	250,000	1,433,750	....	....	....	83,500
1886	15,361,000	250,000	1,845,000	....	....	....	68,510
1888	15,900,000	330,000	1,210,000	....	....	....	71,150
1889	15,750,000	295,000	1,600,000	500,000	350,000	....	70,200
1890	26,650,000	330,000	1,380,000	150,000	568,000	800	89,880
1891	27,995,000	412,500	800,000	125,000	200,000	500	103,700
1892	44,400,000	380,000	1,405,000	....	....	240	139,800
1893	37,516,000	353,000	1,390,000	....	....	612	125,400
1894	21,844,000	302,000	900,000	....	....	800	92,630
1895	31,160,000	280,000	1,662,000	230,000	....	1,800	112,100
1896	29,321,000	214,000	250,000	....	....	4,800	92,000
1897	23,945,000	287,000	....	....	....	4,800	92,100
Calendar year—							
1897	19,256,000	271,000	....	....	....	4,800	72,707
1898	19,654,000	164,300	....	....	....	1,800	55,500
1899	23,067,000	99,200	....	....	....	370	51,800
1900	25,204,214	363,541	....	....	....	3,612	92,200

About 240 tons of miscellaneous freight (merchandise, produce, etc.) were carried in push boats and canoes. In addition, about 4,500 tons of building sand were dredged from the bed of the stream near Charleston and boated to adjacent landings. This, with the timber products as above, makes the total commerce for the year 96,940 tons.

It will be noted that "saw logs and lumber" and "railroad ties" constituted nearly all the traffic. Included in the saw logs and lumber were about 5,000,000 feet B. M. of logs floated loose to the boom at Sutton (100 miles from the mouth of the river) where they were sawed, and the lumber sent to market by rail. The rest of the saw logs and lumber and all of the ties were, with little exception, run out of the river, or to Charleston at the mouth, in rafts.

I I 8.

IMPROVEMENT OF GAULEY RIVER, WEST VIRGINIA.

A brief description of the river and history of the work on it by the United States is given in the Report of the Chief of Engineers for 1900, page 494.

Nothing was done during the year ending June 30, 1901.

No appropriation is now asked for the work.

Money statement.

July 1, 1900, balance unexpended	$308.70
June 30, 1901, amount expended during fiscal year	25.77
July 1, 1901, balance unexpended	282.93
July 1, 1901, outstanding liabilities	4.50
July 1, 1901, balance available	278.43
Amount (estimated) required for completion of existing project	60,000.00

APPROPRIATIONS.

August 11, 1888	$3,000
September 19, 1890	3,000
July 13, 1892	3,000
August 18, 1894	3,000
June 3, 1896	3,000
Total	15,000

COMMERCIAL STATISTICS FOR GAULEY RIVER, WEST VIRGINIA.

About 300 poplar logs, containing about 100,000 feet B. M., or 160 tons, that were cut above Carnifax Ferry, were floated through the "Roughs" into the Kanawha River.

This was practically the only commerce on the river, except the saw logs cut on the Upper Gauley and its tributary, Williams River, and floated on the main stream a distance of from 11 to 28 miles, to the large mill at Camden-on-Gauley, located 67 miles from the mouth of the river. About 12,000,000 feet, or 20,000 tons, were so floated to this mill during the year. This lumber is all sawed at Camden, and shipped out by the West Virginia and Pittsburg Railroad. (See Report of the Chief of Engineers for 1900, part 5, pp. 3340–3343.)

I I 9.

IMPROVEMENT OF GUYANDOT RIVER, WEST VIRGINIA.

The characteristics of this stream and the project for its improvement are described in the Annual Reports of the Chief of Engineers for 1875, pages 747–755; 1895, pages 2517–2520; 1896, pages 2324, 2325, and in the summary of this report.

No work has been done during the last fiscal year.

The last work done was during the fiscal year ending June 30, 1900. It consisted of cleaning the channel of obstructions at a number of the worst places.

A railroad is under construction in the Guyandot Valley, which, if finished, will undoubtedly destroy the small existing boating trade on the river. The latter will then be used solely for floating logs and ties.

No appropriation is asked for continuing the work at the present time.

Money statement.

July 1, 1900, balance unexpended	$0.22
July 1, 1901, balance unexpended	.22

Appropriations.

June 18, 1878	$2,000	September 19, 1890	$2,000
March 3, 1879	1,000	July 13, 1892	2,000
June 14, 1880	2,000	August 18, 1894	2,000
March 3, 1881	3,500	June 3, 1896	1,000
August 2, 1882	2,000	March 3, 1899	1,000
July 5, 1884	2,000		
August 11, 1888	2,000	Total	22,500

COMMERCIAL STATISTICS FOR GUYANDOT RIVER, WEST VIRGINIA.

[These statistics are of doubtful accuracy.]

Year.	Cross-ties.	Timber.	Miscellaneous.	Total.
Fiscal year—	*Tons.*	*Tons.*	*Tons.*	*Tons.*
1891	....	60,000	1,128	61,128
1892	12,500	90,000	1,300	103,800
1893	60,000	120,940	1,310	162,250
1894	40,000	100,000	1,221	141,221
1895	35,000	210,000	2,400	247,400
1896	40,000	160,000	2,000	202,000
1897	50,000	90,000	3,300	143,300
Calendar year—				
1897	80,000	100,000	10,000	190,000
1898	30,000	120,000	8,000	158,000
1899	25,000	80,000	5,000	110,000
1900	30,000	95,000	5,000	130,000

Passengers, calendar year 1900, 500.

The present plan of improvement will not add to the commerce, but only render it possible and safe, and is a necessity for navigation, being chiefly maintenance.

List of boats plying the Guyandot River, West Virginia.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
Guyandotte	Side-wheel	104	16	2.8	43.83
Sandy Valley [a]	....do	105	14	2.8	40
Sadie E	....do	50	9	2.4	9

[a] Wrecked.

I I 10.

IMPROVEMENT OF BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY.

A statement of the original condition, projects, etc., will be found in the summary.

The United States has built one lock and movable dam on this river, which is completed and in operation and is located at Louisa, Ky. The present project provides for twenty-one more, extending slack water from the mouth of the Big Sandy River up the forks to Pikeville on the Levisa, and the mouth of Pond Creek on Tug Fork.

By the act of March 3, 1899, an appropriation of $52,500 was made, of which $1,000 was to be spent for maintenance on Levisa and $1,500 on Tug Fork, $20,000 in a detailed survey of the main river and its forks in Kentucky and West Virginia, and the remainder in the local survey, acquisition of sites, and beginning construction of two locks and dams in the river below Louisa.

At the same time the Secretary of War was authorized to enter into contracts for completing these two dams in a sum not to exceed $420,000, exclusive of the amount appropriated in and before the act, reference being made in the law to the report submitted April 27, 1898.

This money has all been appropriated.

Under the allotment for the survey the work has all been completed and the final report has been made and published as House Doc. No. 235, Fifty-sixth Congress, second session.

Under the allotment for the preliminary work the sites for both locks have been selected, duly surveyed, and the following work accomplished:

At Lock No. 1.—The site chosen is at Catlettsburg, Ky., about one-fourth of a mile from the mouth of the river. The land for the lock and the abutment, with a sufficient number of buildings to give the needed offices, dwellings, and cement sheds, has been purchased and paid for. Plans for the lock have been prepared and approved, a contract for the construction of the lock has been made, and the preparation and delivery of concrete materials and timber is going on. Contracts have also been made for the required cement and operating valves for the lock, and 1,000 barrels of cement have been delivered. Owing to high water no construction work has been attempted.

At Lock No. 2.—The site chosen is at Wright's station, Kentucky, about 13 miles from the mouth of the river. The land needed for the lock and abutment has been acquired by purchase and condemnation. Plans for the lock have been prepared and contracts entered into for its construction and the furnishing of cement and operating valves. The delivery of concrete materials under these contracts is progressing satisfactorily and considerable progress has been made on the construction of the cofferdam. About one-third of the estimated excavation for the lock has been taken out.

A contract was also made for the construction of a lock house, road, fencing, siding, etc., which are nearing completion. A cement shed has been built and has now about 1,500 barrels of Portland cement in it.

Under the original project for open river navigation the river was given a very thorough cleaning of snags and other obstructions. This was paid for by an allotment of $1,000 made July 7, 1900, from the appropriation provided by the emergency river and harbor act approved June 6, 1900. On account of the backwater from the Ohio remaining in this river snags are easily formed, and continued maintenance will be necessary.

The object of the improvement of the river is to bring to market the coal fields which are tributary to the Big Sandy River and its forks.

Congress has already authorized the expenditure of a large sum below Louisa in beginning the execution of the project for improving the river and its forks, but no authority exists for continuing the improvement above Louisa. Until this shall have been done no adequate results can be expected from the series of dams below Louisa. The result of the completion of the entire project can undoubtedly be foretold with accuracy by the time four dams above Louisa on each of the forks have been completed. It will then be known whether the coal deposits tributary to the river will seek that outlet to market in sufficient volume to justify a continuation of the improvement. It is estimated that these four dams will cost, on Tug Fork $1,015,000, and on Levisa Fork $1,090,000.

For reasons given in the final report on survey dated November 26, 1900, regulating works, reaching from the lower lock to the Ohio River, will be required. Their cost is estimated at $40,000.

The survey of the forks above Louisa indicates that economy can be effected in the locations of the first dams above that point by raising the height of the existing dam at Louisa. This increased elevation will carry the full depth to points on the forks where favorable locations and foundations for the two dams next above can be found. This modification of the Louisa dam should be undertaken, or at least authorized, before the definite location of the first dams above Louisa has been made. The cost of it is estimated at $35,000.

The limit of authority for continuing contracts for the two locks and dams below Louisa, as stated in the act of March 3, 1899, is less by $50,000 than the estimated cost of these structures, as stated in Major Bixby's report of April 27, 1898, upon which the legislation is based.

That project estimated the cost of the lower dams at $250,000 each. The sum authorized, being 10 per cent less, will not give to the dams certain desirable features for their safe and satisfactory operation, and on this account the limit of authority for these two dams should be extended to include the entire estimated cost of the structures.

For the foregoing reasons the continuation of the improvement of the Big Sandy River and its forks should embrace regulating works below the lower lock, a raising of the dam at Louisa, the continuation of work on the two dams below Louisa, and the extension of the slackwater system into the forks above Louisa.

The estimate given below of the amount which can profitably be expended in the year ending June 30, 1903, is based upon the assumption that both locks and dams will be finished by that time at the cost as originally estimated, viz, $250,000 each, and that in addition the sum of $200,000 will be expended in local surveys, acquisition of sites and commencing construction of two locks and dams above Louisa in Levisa and Tug forks, $40,000 in the regulating works at the junction of Big Sandy with the Ohio, and $35,000 in the alteration of the dam at Louisa.

Money statement.

July 1, 1900, balance unexpended		$289,097.15
Amount appropriated by sundry civil act approved March 3, 1901		140,000.00
		429,097.15
June 30, 1901, amount expended during fiscal year		24,983.62
July 1, 1901, balance unexpended		404,113.53
July 1, 1901, outstanding liabilities		1,496.87
July 1, 1901, balance available		402,616.66
July 1, 1901, amount covered by uncompleted contracts		243,736.72
Amount (estimated) required for completion of existing project		4,255,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901:		
For works of improvement	$325,000.00	
For maintenance of improvement	[1]1,000.00	
		326,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

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[1] Exclusive of sum required for operating and care lock and dam.

APPROPRIATIONS.

July 18, 1878	$12,000	July 13, 1892	$50,000
March 3, 1879	12,000	August 18, 1894	40,000
June 14, 1880	50,000	June 3, 1896	30,000
March 3, 1881	46,000	March 3, 1899	50,000
August 2, 1882	15,000	June 6, 1900	280,000
July 5, 1884	40,000	June 6, 1900 (allotted)	1,000
August 5, 1886	22,500	March 3, 1901	140,000
August 11, 1888	31,500		
September 19, 1890	31,000	Total	851,000

ABSTRACTS OF CONTRACTS IN FORCE ON BIG SANDY RIVER, JUNE 30, 1901.

Contract for constructing Lock No. 1, Big Sandy River, West Virginia and Kentucky.

Name of contractors: Folz and Jonte.
Date of approval: November 3, 1900.
Date of beginning: On or before December 6, 1900.
Date of expiration: August 7, 1902.

Items.	Contract price (unit rate).	Items.	Contract price (unit rate).
Piling (round) .... per linear foot..	$0.45	Loose rock .... per cubic yard..	$1.00
Cofferdam timber... per M. feet B. M..	39.00	Solid rock .... do....	1.00
Timber in permanent work .... do....	39.00	Deposit .... do....	.20
Stone masonry .... per cubic yard..	90.00	Embankment .... do....	.25
Paving .... per square yard..	2.00	Puddling .... do....	3.00
Riprap .... per cubic yard..	2.00	Cofferdam filling .... do....	1.00
Concrete .... do....	4.50	Structural steel .... per pound..	.05
Earth excavation .... do....	.60	Cast iron .... do....	.05

Contract for constructing Lock No. 2, Big Sandy River, West Virginia and Kentucky.

Name of contractor: The Evansville Contract Company.
Date of approval: December 17, 1900.
Date of beginning: January 18, 1901.
Date of expiration: September 19, 1902.

Items.	Contract price (unit rate).	Items.	Contract price (unit rate).
Piling (round) .... per linear foot..	$0.50	Loose rock .... per cubic yard..	$0.25
Cofferdam timber .. per M. feet B. M..	60.00	Solid rock .... do....	1.00
Timber in permanent work .... do....	75.00	Deposit .... do....	.20
Stone masonry ...... per cubic yard..	50.00	Embankment .... do....	.25
Paving .... per square yard..	2.80	Puddling .... do....	3.00
Riprap .... per cubic yard..	3.00	Cofferdam filling .... do....	1.00
Concrete .... do....	4.00	Structural steel .... per pound..	.035
Earth excavation .... do....	.50	Cast iron .... do....	.035

Contract for constructing one frame dwelling house, outhouse, cistern, road, siding, and fence, at or near the site of Lock No. 2, Big Sandy River, West Virginia and Kentucky.

Name of contractor: Joseph M. Neil.
Date of approval: December 8, 1900.
Date of beginning: December 20, 1900.
Date of expiration: On or before July 1, 1901.[1]

Items.	Contract price.	Items.	Contract price.
Dwelling, complete, except excavation	$1,989.56	Timber, including iron, per M feet. B. M	$21.75
Outbuilding, vault, drains, yard, fence, and walks, complete, except excavation	348.92	Masonry .... per cubic yard..	4.75
Cistern, complete, except excavation .	75.00	Fence, including gates and post holes .... per linear rod..	1.15
Excavation, including removal and deposit .... per cubic yard..	.35	Cross-ties, in place .... each..	.45

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[1] Extended to July 31, 1901.

Contract for furnishing Portland cement (Old Dominion brand) for locks Nos. 1 and 2, Big Sandy River, West Virginia and Kentucky.

Name of contractor: Virginia Portland Cement Company. .
Date of approval: March 28, 1901.
Date of beginning: First consignment to be ordered for delivery on or about April 30, 1901.
Date of expiration: Contingent upon progress of work. To expire by limitation on June 1, 1902, unless it be desired to purchase additional cement for the dams, as provided for in paragraph 39 of specifications.

Items.	Contract price.
Old Dominion Portland cement delivered at Catlettsburg, Ky.—2,500 barrels, minimum; 10,000 barrels, maximum. Delivered at Wrights, Ky.—3,500 barrels, minimum; 12,000 maximum):	
In standard paper bags .... per barrel..	$1.35
In barrels .... do....	1.50

Contract for furnishing Portland Cement (Lehigh brand) for Locks Nos. 1 and 2, Big Sandy River, West Virginia and Kentucky.

Name of contractor: Lehigh Portland Cement Company.
Date of approval: March 28, 1901.
Date of beginning: First consignment to be ordered for delivery on or about April 30, 1901.
Date of expiration: Contingent upon progress of work. To expire by limitation on June 1, 1902, unless it be desired to purchase additional cement for the dams, as provided for in paragraph 39 of specifications.

Items.	Contract price.
LEHIGH PORTLAND CEMENT.	
Delivered at Catlettsburg, Ky. (4,000 barrels, minimum, 10,000 barrels, maximum):	
In standard paper bags .... per barrel..	$1.45
In barrels .... do....	1.63
Delivered at Wrights, Ky. (6,000 barrels, minimum, 12,000 barrels, maximum):	
In standard paper bags .... per barrel..	1.56
In barrels .... do....	1.75

Contract for furnishing automatic and nonautomatic valves, including operating gears, seats, and all other parts complete, for Locks Nos. 1 and 2, Big Sandy River, West Virginia and Kentucky.

Name of contractor: Chas. Hegewald Company.
Date of approval: March 30, 1901.
Date of beginning: May 4, 1901.
Date of expiration: Paragraph 49 of specifications provides that the valve seats and fixed parts of iron work belonging in the lower portions of the masonry must be delivered on or before June 1, 1901, and the remainder on or before August 1, 1901

Items.	Contract price.
4 pairs of automatic valves[a] .... per pair, complete..	$734
4 pairs of nonautomatic valves[a] .... do....	689

[a] 2 pairs of each to be delivered at Catlettsburg, Ky., and 2 pairs of each to be delivered at Wrights, Ky.

COMMERCIAL STATISTICS.

Big Sandy River, West Virginia and Kentucky, for fiscal year ending June 30, 1901, and prior years.

Articles.	1895.	1896.	1897.	1898.	1899.	1900.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Timber	425,000	313,332	255,000	200,000	210,000	200,000
Hides	....	....	....	....	78	....
Leather	....	....	....	....	....	....
Lumber	500	370	300	300	....	....
Produce	3,000	2,360	5,000	12,000	13,300	15,000
Live stock	1,360	1,280	1,400	10,000	1,149	2,000
Spokes	50	100	....	....	....	....
Staves	1,000	480	1,000	2,000	452	1,000
Tan bark	800	1,000	800	500	....	....
Ties	32,100	51,100	48,000	90,000	48,000	50,000
Grain	....	....	500	600	609	500
Wool	....	....	....	....	....	....
Miscellaneous	80,000	100,000	100,000	100,000	69,820	29,000
Passengers	2,100	1,360	2,500	2,000	2,375	2,500
Total	545,910	471,382	414,500	417,400	345,778	300,000

No new lines of transportation have been established.

Big Sandy River, West Virginia and Kentucky, for calendar year ending December 31, 1900.

Timber	tons..	200,000
Ties	do...	50,000
Staves	do...	1,000
Miscellaneous	do...	45,000
Total		296,000
Passengers	number..	25,000

List of boats plying Big Sandy River, West Virginia and Kentucky, and Tug and Levisa forks of same.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
Big Sandy	Side-wheel	110	14	1.8	24.12
Jennie George	do	93	14	....	19.05
Sandy Valley[a]	do	105	14	2.8	40
Sea Lion (tow)	Stern-wheel	123	22	3.5	127
Louisa	Side-wheel	90	9	2	....
Maxie Yost	do	117.6	15.6	....	47.12
H. G. Stafford	do	84	8	1.10	7.71
Bellevue (tow)	Stern-wheel	125	22	3.5	127
Argand	do	130	25	4.5	96.25
Cando	do	117.5	20	3	74
Alka	Side-wheel	116	19.2	3.2	45
Venus (tow)	Stern-wheel	90	18	3	49.75
J. M. Grubbs (tow)	do	90	20	3.2	47
Cricket	do	132	18.3	2.9	51
Yellow Poplar (tow)	do	128	26	4	123
Catharine Davis (tow)	do	135	26	4	210
John C. Fisher (tow)	do	131	25	3.5	156

[a] Wrecked.

List of vessels, rafts, etc., passing lock and dam on Big Sandy River during the calendar year ending December 31, 1900.

Craft.	Up.	Down.	Total.
Steamboats	201	200	401
Barges and flats	69	76	145
Miscellaneous	3	....	3
Merchandise ...tons..	45	23	68
Rafts	....	3,818	3,818
Ties	....	142,709	142,709

I I 11.

OPERATING AND CARE OF LOCK AND DAM ON BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY.

The only completed lock and dam on this river at present is located near Louisa, Ky., and was completed and opened to navigation January 1, 1897.

The dam is movable and of the needle type. A full description is given in the Annual Report of the Chief of Engineers for 1897, pages 2534 et seq.

The dam was lowered for the winter on December 31, 1900, and had not been raised again at the date of this report.

The stated repairs projected in the approved estimate for the year ending June 30, 1901, consisted in placing new rack bars on the lock gates, a tile gage on outside of lock wall, replastering and otherwise repairing a portion of one of the lock buildings, which had formerly been used as an office, constructing cement steps and walks from the abutment end of dam to the top of river bank, building a fence along the bank in order to keep cattle off the premises and mending eroded and broken places in the protection stone below abutment. This has been finished, certain unforeseen repairs have been made, and the lock, dam, and appurtenances have been operated and cared for. The total expenditure has been $3,648.12, including outstanding liabilities June 30, 1901.

Commercial statistics are included in the report for improving Big Sandy River.

ALLOTMENTS.

July 23, 1897	$2,840.00	July 19, 1899	$3,524.28
July 23, 1898	3,250.95	July 18, 1900	3,177.09

Summary of expenditures for operating and care of lock and dam on Big Sandy River, West Virginia and Kentucky, for the fiscal year ending June 30, 1901.

Office expenses, superintendence, and contingencies	$565.00
Labor	2,201.84
Fuel	7.50
Expenses	373.45
Repairs	329.42
Total	3,477.21

Maneuvers of lock and dam in Big Sandy River, West Virginia and Kentucky, near Louisa, Ky., for the fiscal year ending June 30, 1901.

Maneuver.	Date.	Maneuver.	Date.
Lowered	July 27.	Raised	Dec. 15.
Raised	Aug. 4.	Lowered	Dec. 31.
Lowered	Nov. 21.		

I I 12.

IMPROVEMENT OF TUG FORK OF BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY.

A statement of the original condition, projects, etc., will be found in the summary.

Owing to lack of funds no work has been done during the past fiscal year.

The final report on the survey made under provision of the river and harbor act of March 3, 1899, was submitted during the year and was published as House Doc. No. 235, Fifty-sixth Congress, second session.

The original project for open-river regulation has been practically completed, but a small annual expenditure will be required for maintenance until the project for extending slack water to the mouth of Pond Creek shall have made considerable progress.

Money statement.

July 1, 1900, balance unexpended	$27.15
July 1, 1901, balance unexpended	27.15
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement, in addition to the balance unexpended July 1, 1901	1,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

APPROPRIATIONS.

June 14, 1880	$2,500	July 13, 1892	$2,500
March 3, 1881	2,000	August 18, 1894	2,500
August 2, 1882	5,000	June 3, 1896	2,000
July 5, 1884	5,000	March 3, 1899	1,500
August 5, 1886	3,750		
September 19, 1890	2,500	Total	29,250

COMMERCIAL STATISTICS FOR CALENDAR YEAR ENDING DECEMBER 31, 1900, FOR TUG FORK OF BIG SANDY RIVER, KENTUCKY AND WEST VIRGINIA.

[These statistics are of doubtful accuracy.]

Year.	Timber.	Ties.	Staves.	Tan bark.	Miscellaneous.	Passengers.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	
1897	85,000	20,000	200	200	30,000	2,000
1898	70,000	25,000	300	100	35,000	1,000
1899	80,000	18,000	200	....	30,000	1,500
1900	70,000	20,000	....	....	30,000	1,500

I I 13.

IMPROVEMENT OF LEVISA FORK OF BIG SANDY RIVER, KENTUCKY.

A statement of the original condition, projects, etc., will be found in the summary.

Under the original project for open-river navigation the river was given a very thorough cleaning of snags and other obstructions. This was paid for by an allotment of $1,000, made July 7, 1900, from the appropriation provided by the emergency river and harbor act approved June 6, 1900.

The final report on the survey, made under provision of the river and harbor act of March 3, 1899, was submitted during the year, and was published as House Doc. No. 235, Fifty-sixth Congress, second session.

The original project for open-river regulation has been practically completed, but a small annual expenditure will be required for maintenance until the project for extending slack water to Pikeville shall have made considerable progress.

Money statement.

July 1, 1900, balance unexpended	$1,070.41
July 30, 1901, amount expended during fiscal year	1,001.07
June 1, 1901, balance unexpended	69,34
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement, in addition to the balance unexpended July 1, 1901 Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	2,000.00

APPROPRIATIONS.

June 14, 1880	$2,500	August 18, 1894	$2,500
March 3, 1881	2,000	June 3, 1896	1,000
August 2, 1882	5,000	March 3, 1899	1,000
July 5, 1884	5,000	June 6, 1900	1,000
August 5, 1886	3,750		
September 19, 1890	2,500	Total	28,750
July 13, 1892	2,500		

COMMERCIAL STATISTICS FOR CALENDAR YEAR ENDING DECEMBER 31, 1900, FOR LEVISA FORK OF BIG SANDY RIVER, KENTUCKY.

[These statistics must be considered as of doubtful accuracy.]

Year.	Timber.	Ties.	Staves.	Tan bark.	Miscellaneous.	Passengers.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	
1897	150,000	20,000	500	300	50,000	10,000
1898	110,000	40,000	1,000	300	60,000	10,000
1899	100,000	28,000	250	....	30,000	10,000
1900	90,000	29,700	300	....	30,000	10,000

I I 14.

IMPROVEMENT OF KENTUCKY RIVER, KENTUCKY.

The work was begun by the Commonwealth of Kentucky and turned over to the United States in 1879. A statement of its condition then, and of the projects under which it has since been carried on, will be found in the Annual Report of the Chief of Engineers for 1898, pages 2012 et seq.

Eight locks and dams are now open to navigation, and during the past fiscal year a contract has been let for the construction of the ninth lock and dam. This one will be of the same dimensions as No. 8; it is located at Valleyview, Ky., a distance of 158 miles from the mouth of the river. Information as to the location and dimensions of the locks and dams already built will be found in the Annual Report of the Chief of Engineers for 1899, page 2523.

The work during the fiscal year has been as follows:

Lock No. 8.—Completed the masonry of the lock, hung the gates, finished constructing the approach cribs, constructed the dam. All contract work at this lock has been finished. The lock was opened to navigation on October 15, 1900.

Pool No. 8.—Until August 10, 1900, a party of ten men had been in the field with a quarterboat cutting the overhanging trees along the water lines of Pool No. 8, and removing all snags within 7 feet of the pool level.

Lock No. 9.—The title for the site for the lock has been acquired by purchase, and that for the abutment has been condemned.

Borings into solid rock were made to determine its character; plans and specifications for the lock were prepared. A contract for the erection of two lock tenders' dwellings has been entered into with M. F. Wharton, and construction has begun. A contract for the building of Lock and Dam No. 9 has been entered into with the Sheridan-Kirk Contract Company; preliminary work was commenced, and the excavating by dredge for the walls of the lock has been nearly completed.

Locks Nos. 10, 11, and 12.—Surveys of the river and of selected sites for these locks and dams were made, the total length of the survey being 43.7 miles. The title to the site for No. 10 has been investigated and submitted to the United States attorney for the district of Kentucky for his opinion as to its validity. The land on the abutment site can be purchased, an agreement having been made with the three owners; that on the lock side requires condemnation.

The title to site of No. 11 is being investigated.

The improvement is among those reported as requiring special mention in connection with further appropriations in the report of the Chief of Engineers, dated December 2, 1899, and printed as House Doc. No. 230, Fifty-sixth Congress, first session. It is there stated that the limit of expenditure authorized by the acts of Congress under which work is now carried on will not complete the project, and that when the work is completed to the extent permitted by existing legislation the subject of extending the improvements will be a proper one for consideration. It is probable that the limit authorized by existing legislation for continuing contracts will be reached while Lock No. 12 is under construction and before its completion, leaving that lock and two more of the series to be completed under future legislation, if at all.

The estimate submitted below for the amount which can be profitably expended during the fiscal year ending June 30, 1903, is based upon the assumption that it will be possible to acquire the site for Lock and Dam No. 12, to complete Locks Nos. 9 and 10, to build lock tenders' dwelling at Locks 11 and 12, and to do about one-quarter of the work on Locks and Dams 11 and 12.

The commercial statistics are given in the report for operating and care of locks and dams on the Kentucky River.

Money statement.

July 1, 1900, balance unexpended	$391,591.83
Amount appropriated by sundry civil act approved March 3, 1901	150,000.00
	541,591.83
June 30, 1901, amount expended during fiscal year	82,226.81
July 1, 1901, balance unexpended	459,365.02
July 1, 1901, outstanding liabilities	1,303.46
July 1, 1901, balance available	458,061.56
July 1, 1901, amount covered by uncompleted contracts	208,126.25
Amount (estimated) required for completion of existing project	2,335,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	200,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

March 3, 1879	$100,000.00	July 1, 1898	$350,000.00
June 14, 1880	100,000.00	June 6, 1900	75,000.00
March 3, 1881	125,000.00	March 3, 1901	150,000.00
August 3, 1882	225,000.00		
July 5, 1884	250,000.00	Total	2,530,500.00
August 5, 1886	187,500.00	Received from Tabor & Cogar, October, 1888	500.00
August 11, 1888	180,000.00		
September 19, 1890	180,000.00	July 13, 1899, overpayment refunded	.20
July 13, 1892	150,000.00		
August 18, 1894	125,000.00	Received from O'Brien & Gulden, March 31, 1893	6,000.00
June 3, 1896	50,000.00		
June 3, 1896	83,000.00		
June 4, 1897	200,000.00	Total	2,537,000.20

ABSTRACT OF CONTRACTS IN FORCE ON KENTUCKY RIVER JUNE 30, 1901.

Contract for constructing two frame dwelling houses, two coal sheds with privies, one frame office and tool room combined, two cisterns, cement sidewalks, and drains, at the site of Lock No. 9, Kentucky River, Kentucky.

Name of contractor, M. F. Wharton.
Date of approval, February 8, 1901.
Date of beginning, March 11, 1901.
Date of expiration, July 11, 1901.[1]

Items.	Contract price.	Items.	Contract price.
Two dwelling houses and two coal sheds, with privies, complete....for the lot..	$4,730.00	Two cisterns, complete....for the lot..	$710.00
One office and tool room combined, complete.................for the lot..	366.00	Sidewalk, in place ...per square yard..	3.75
		Drains, in place....... per linear foot..	.25

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[1] Extended to August 14, 1901.

Contract for constructing Lock and Dam No. 9, Kentucky River, Kentucky

Name of contractor: The Sheridan-Kirk Contract Company.
Date of approval: June 12, 1901.
Date of beginning: July 15, 1901.
Date of expiration: June 15, 1903.

Items.	Contract price (unit rate).	Items.	Contract price (unit rate).
Ballast..............per cubic yard..	$1.50	Iron and steel............per pound..	$0.045
Cofferdam filling..............do....	.50	Masonry............per cubic yard..	50.00
Cofferdam timber...per M feet B. M..	35.00	Paving, if concrete..per square yard..	1.75
Concrete............per cubic yard..	3.90	Paving, if stone..............do....	2.75
Deposit.......................do....	.50	Piles...............per linear foot..	.50
Driftbolts...............per pound..	.035	Timber in permanent construction, per M feet B. M................	42.00
Excavation, earth....per cubic yard..	.40		
Excavation, rock..............do....	3.00	Valves......................per set..	500.00
Embankment.................do....	.35	Winches......................do....	100.00
Fence in place........per linear foot..	.25		
Hauling cement:			
If delivered by rail ...per barrel..	.07		
If delivered by water.......do....	.07		

Contract for furnishing Portland cement (Old Dominion brand) for Lock and Dam No. 9, Kentucky River, Kentucky.

Name of contractor: Virginia Portland Cement Company.
Date of approval: June 18, 1901.
Date of beginning: First consignment to be ordered for delivery about July 15, 1901.

Date of expiration: Paragraph 39 of the specifications provides that deliveries may be required until October 1, 1902, on which date the contract will expire by limitation. The right is reserved to close the contract at any time after the delivery of the minimum number of barrels called for.

Item.	Contract price.
Portland cement, Old Dominion brand (11,200 barrels, minimum; 20,000 barrels, maximum): Delivered free on board cars at Valleyview, Ky., in standard paper bags....per barrel..	$1.73

Contract for furnishing natural cement (Star brand) for Lock and Dam No. 9, Kentucky River, Kentucky.

Name of contractor: J. B. Speed & Co.
Date of approval: June 24, 1901.
Date of beginning: First consignment to be ordered for delivery about July 15, 1901.

Date of expiration: Paragraph 39 of the specifications provides that deliveries may be required until October 1, 1902, on which date the contract will expire by limitation. The right is reserved to close the contract at any time after the delivery of the minimum number of barrels called for.

Item.	Contract price.
Natural cement, Star brand (2,800 barrels, minimum; 5,000 barrels, maximum): Delivered free on board cars at Valleyview, Ky., in standard paper bags...per barrel..	$0.84

II 15.

OPERATING AND CARE OF LOCKS AND DAMS ON KENTUCKY RIVER, KENTUCKY.

This river has eight complete locks with fixed dams, five having been built by the Commonwealth of Kentucky and three by the United States. Six more are required to complete the project, one of which is now under contract.

During the past year navigation above Lock No. 8 was suspended for ten days on account of certain repairs to the gates, and above No. 7 for twenty-five days on account of the washing out of the lower gates. High water interrupted navigation for an average of six days at each lock, the least number of days being two at Lock No. 3, and the greatest twelve days at Lock No. 7. There was no suspension of navigation on account of ice.

The entire system so far as yet completed was in good navigable condition at the close of the year.

The special work projected in the approved estimate for the fiscal year ending June 30, 1901, consisted in the construction of a new dredge hull and certain stated repairs. The repairs and present condition of work are as follows:

At Lock No. 1.—The repairs to the abutment crib, to the dam, and to the lock gates were postponed until a date, as soon after July 15, 1901, as practicable, when the water should be low enough to commence operations. The paving behind part of the upper land crib was relaid.

At Lock No. 2.—Repair of the upper part of the upper land and upper river cribs. This work has been finished. Owing to high water the repairs to the dam sheeting were not made.

Tear down and rebuild both lower cribs. This has not been done, as it is proposed to do it when Pool No. 1 is drained for repairs to Dam No. 1.

At Lock No. 3.—Repair of triangular crib; this has been finished. Repair upper cribs and dam; this work has not been done, as it is dependent upon the time when repairs are being made at Dam No. 1, and navigation is suspended on account of draining the pools.

At Lock No. 5.—Repair of upper river and triangular cribs, and fill washout behind lower land crib; this work has been finished. Rebuild lower gates; the timber has been purchased, but the gates have not yet been built.

At Lock No. 6.—Fit bevel gear to wickets and provide new spar; neither of these items has been done.

New dredge.—The machinery for a new dredge was purchased and the hull contracted for and about 90 per cent completed.

The present condition of the works is all good except as follows:

At Lock No. 1.—Lower land crib will have to be rebuilt within two years.

At Lock No. 2.—Part of the upper land crib will have to be rebuilt within two years. Both lower cribs are to be rebuilt during the coming year.

At Lock No. 3.—The lower land crib will have to be rebuilt within two years.

At Lock No. 4.—The lower land crib will have to be rebuilt within the next two years.

At Lock No. 5.—The lower river crib will have to be rebuilt within the next two years.

At Lock No. 7.—The lower lock gates should be replaced with new steel gates.

At Lock No. 8.—The paving behind the lock wall requires to be supported, replacing the washed-out filling.

In addition to the work above outlined, certain unforeseen repairs have been made, and the locks, dams, and appurtenances have been operated and cared for. The total expenditure has been $74,789.21, including outstanding liabilities June 30, 1901.

ALLOTMENTS.

July, 1884	$15,000.00	June 13, 1893	$2,000.00
July, 1885	27,615.00	July 14, 1893	73,065.02
July 31, 1886	33,965.00	July 16, 1894	46,435.28
July, 1887	79,862.14	July 20, 1895	59,120.04
July, 1888	82,478.50	July 24, 1896	70,198.85
July 28, 1889	72,394.80	August 2, 1897	49,272.11
July 17, 1890	28,889.07	July 15, 1898	53,531.39
July 16, 1891	36,331.38	July 29, 1899	63,884.24
November 28, 1891	1,112.50	May 11, 1900	2,500.00
December 14, 1891	11,382.80	July 17, 1900	82,284.09
July 15, 1892	38,503.62	Total	929,825.83

Contract for furnishing 2,200 cubic yards of stone filling delivered at the site of Lock and Dam No. 1, Kentucky River, Kentucky.

Name of contractor: Disken & Cox.	Date of beginning: June 13, 1901.
Date of approval: May 31, 1901.	Date of expiration: September 13, 1901.

Items.	Contract price.
2,200 cubic yards of stone filling, delivered at site of Lock and Dam No. 1, Kentucky River, Kentucky ...for the lot..	$2,860

Summary of expenditures for operating and care of locks and dams on Kentucky River, Kentucky, for the fiscal year ending June 30, 1901:

Office expenses, superintendence, and contingencies	$6,954.83
Labor	25,682.72
Subsistence	2,033.40
Fuel	1,005.26
Expenses	17,884.83
Repairs	15,376.63
Total	71,419.10

COMMERCIAL STATISTICS.

Statement of traffic passing the locks on Kentucky River during the calendar years 1899 and 1900.

Lock No.	Passenger boats.		Towboats.		Government boats.		Coal barges.		Other barges.		Small crafts.	
	1899.	1900.	1899.	1900.	1899.	1900.	1899.	1900.	1899.	1900.	1899.	1900.
1	900	1,007	172	160	41	36	225	205	141	196	77	64
2	819	705	169	162	44	32	191	181	113	97	72	43
3	343	371	162	134	56	40	188	176	207	90	69	49
4	344	380	179	172	80	48	193	194	145	135	87	135
5	234	262	64	65	89	66	68	61	402	132	103	146
6	188	209	47	40	76	57	27	33	125	120	163	135
7	167	196	33	25	68	61	21	28	206	109	172	175
8	......	13	......	6	......	2	......	2	......	70	......	20
Total	2,995	3,143	826	764	454	342	913	880	1,339	949	743	767

Lock No.	Rafts.		Total.		Increase (+) or decrease (−).a	Total tonnage.		Increase (+) or decrease (−) tonnage.a	Lockages.	
	1899.	1900.	1899.	1900.	1900.	1899.	1900.	1900.	1899.	1900.
1	163	335	1,719	2,003	+ 284	203,237	185,121	−18,116	1,400	1,583
2	165	342	1,573	1,862	− 11	187,580	166,068	−21,512	1,362	1,280
3	159	339	1,184	1,199	+ 15	159,482	149,588	− 9,894	986	1,030
4	165	331	1,193	1,395	+ 202	158,851	157,664	− 687	1,029	1,114
5	808	1,266	1,768	1,998	+ 230	182,956	168,948	−14,008	1,119	1,325
6	806	1,289	1,432	1,883	+ 451	121,628	154,609	+32,981	750	883
7	814	1,284	1,481	1,878	+ 397	127,000	152,592	+25,592	871	859
8	......	93	......	206	+ 206	....	22,039	+22,039	......	135
Total	3,080	5,279	10,350	12,124	+1,774	1,140,234	1,156,629	+16,395	7,517	8,209

a (+) increase; (−) decrease.

NOTE.—Lock No. 8 opened to navigation October 15, 1900.

The increase of tonnage passing the locks during the calendar year ending December 31, 1900, over the previous year is 16,395 tons.

No new lines of transportation established during the year.

Statement of commerce in tons passing the locks on Kentucky River, during the calendar years 1899 and 1900.

Articles.	Lock No. 1.		Lock No. 2.		Lock No. 3.		Lock No. 4.	
	1899.	1900.	1899.	1900.	1899.	1900.	1899.	1900.
Coal	55,273	53,147	51,179	47,055	47,159	46,409	46,218	44,430
Grain	4,858	8,391	4,529	8,170	4,280	6,877	4,382	7,645
Salt	748	768	571	566	540	443	316	345
Oil	530	493	394	280	225	176	231	186
Whisky	1,476	1,239	1,648	1,343	1,644	1,387	1,574	1,207
Flour	1,287	1,286	725	725	340	414	307	311
Sugar	371	277	217	188	131	115	116	68
Molasses	182	138	169	91	64	80	62	66
Cement	1,317	499	1,184	353	1,055	240	1,249	179
Hides	34	41	61	17	1	7	1	1
Tobacco	4,078	4,385	2,467	2,924	1,047	1,103	362	432
Hay	1,703	932	490	537	358	351	345	352
Live stock	1,377	931	594	450	284	231	110	183
Lumber and timber	13,206	24,697	12,511	25,174	10,947	27,783	13,001	23,204
Shingles	332	934	188	343	96	188	72	177
Manufactured iron	521	290	463	418	369	268	888	143
Produce	731	534	411	236	129	66	117	139
General and miscellaneous	8,627	14,841	6,038	6,483	3,906	4,778	3,632	4,937
Total	96,651	113,823	83,809	35,358	72,370	90,866	72,983	84,005
Number of passengers	9,059	8,900	6,118	6,285	3,887	4,867	3,995	4,167

Articles.	Lock No. 5.		Lock No. 6.		Lock No. 7.		Lock 8.
	1899.	1900.	1899.	1900.	1899.	1900.	1900.
Coal	16,219	13,664	5,528	7,278	4,996	6,525	163
Grain	3,756	5,840	3,726	5,445	3,451	4,786	6
Salt	165	150	119	89	94	100	21
Oil	102	41	53	27	31	13	....
Whisky	1,570	1,622	1,456	1,235	1,512	1,322	....
Flour	239	60	75	56	49	34	3
Sugar	24	11	12	8	6	2	1
Molasses	5	13	4	13	2	4	....
Cement	794	70	782	65	644	123	5
Hides	4	2	1	1	1	....	....
Tobacco	280	273	152	156	192	87	4
Hay	127	143	48	26	53	29	....
Live stock	72	74	32	43	43	45	10
Lumber and timber	58,722	95,172	60,229	96,963	57,445	99,463	8,023
Shingles	88	147	27	2	12	10	....
Manufactured iron	182	68	65	67	91	115	1
Produce	31	10	23	8	186	13	10
General and miscellaneous	1,546	2,351	968	1,695	25,571	14,734	101
Total	83,866	119,711	78,300	113,192	94,379	127,405	8,348
Number of passengers	3,244	3,300	2,468	3,196	3,078	2,816	142

NOTE.—The miscellaneous for Lock No. 7 includes 25,000 tons of dimension stone in 1899 and 12,976 tons in 1900.

List of boats plying the Kentucky River, Kentucky, during the calendar year ending December 31, 1900.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
Gen'l O. M. Poe	United States towboat	145.60	34	4.6	150
Pearl	United States launch	40	8	4	5
Falls City	Packet	158.80	37	6	235
Chas. B. Pearce	do	132.50	27	4.4	223.35
Dick Brown	do	132	24	4.5	148.99
John Barrett	do	124.80	31	5.5	187.23
Golden Gate	do	100	22	3	100
Burnsides	do	136	21	4.6	92.11
Argand	do	148	28	4.6	96
Sun	do	124	23.4	4.3	84
Elva	do	80	20.6	3	58

List of boats plying the Kentucky River, Kentucky, etc.—Continued.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
Eva Alma	Packet	111.02	16.6	3.6	48
Minnie	do	80	16	3.6	31.76
Lotus	do	76.50	12.1	2.9	20.15
Fannie	do	55	11	2.4	10
Charley Boy	do	58	10.5	2.6	44.96
Hazel	do	56	11	2.4	10
Vixen	do	56	12	3	14
Three Friends	do	55	8	2	5
Quick Step	do	42.20	11.2	5	5.53
Rabbit Foot	do	44	12	4	8
Juniata	do	33	7.6	2	5
Ida Viola	do	32.08	15.2	4	8.23
Ensign	do	33	7.5	2.8	5
Gunther	do	30	7	3.5	4.50
Dauntless	do	30	7	3.5	5
Dove	do	28	8	2.6	11
Nettie M	do	25	5.8	4	3
Uncle Sam	Towboat	109.40	20	3.2	57
Lulu F	do	110	18	2.1	53
Reba Reeves	do	107	22	3.4	63.11
S. D. Blair	do	100	24	4.6	93
Louise	Tugboat	60.40	9.5	2	9.43
Edmund	do	56	12	3	14
Tom Ross	do	33	7.8	3.6	9.72
Bob Lee	do	33	6	2.6	4.50
Dixie	Pleasure boat	45	8.6	4	3.72
Rising Sun	do	40	7.5	2.4	5
Monita	do	36	8	4.3	3.72
Pixen	do	34	6	4.6	4
Katherine L	do	30	6.6	3	4
Helen	do	35	8	4.5	3
Success	do	24	8	2	4
Emily	do	25	6	2.6	1.50
T. B. Rippy	do	25	6	2.5	2
Ebbie	do	25	6	2.7	1.50
Clipper	Sawmill boat	133.60	25	3.4	98
Rover	do	100	28	3.5	100
Sawyer	do	93.40	29	2.9	39.93

List of leases in force for the fiscal year ending June 30, 1901, Kentucky River, Kentucky.

Location.	Lessee.	Dated.	Expires.	Annual rental.
Lock No. 4	Kentucky River Mills	July 10, 1878	July 10, 1977	$180

I I 16.

FINAL REPORT ON SURVEY OF BIG SANDY RIVER, KENTUCKY AND WEST VIRGINIA, INCLUDING LEVISA AND TUG FORKS.

[Printed in House Doc. No. 235, Fifty-sixth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, December 19, 1900.

SIR: The river and harbor act of March 3, 1899, appropriated $52,500 for improving Big Sandy River, Kentucky and West Virginia, and provided for the expenditure of $20,000 of this amount, or so much thereof as might be necessary, for a detailed survey of said river, including the Tug and Levisa forks. A preliminary report, dated January 10, 1900, by Capt. H. F. Hodges, Corps of Engineers, upon the survey authorized was submitted to the Secretary of War with my letter of January 18, 1900, and is printed in House Doc. No. 326, Fifty-sixth Congress, first session, and also in my annual report for 1900, page 3400 et seq.

I have now the honor to submit the accompanying copy of final report on this survey, dated November 26, 1900, with map, by Captain Hodges. In referring to his preliminary report Captain Hodges states that it contains a valuable report of Prof. C. N. Brown upon the mineral wealth of the Big Sandy Valley, and that the information on the points covered by Professor Brown is not treated again in the report now submitted.

This river has been under improvement by the United States since 1878, the present plan of improvement, adopted by the river and harbor act of March 3, 1899, contemplating slack-water navigation from the Ohio River up to Pikeville on Levisa Fork, and up to the mouth of Pond Creek on Tug Fork, by the construction of 21 locks and movable dams in addition to the one now built at Louisa, Ky., of which 10 are proposed for Levisa Fork, 8 for Tug Fork, and 3 for the main river below Louisa. The cost of this work is estimated in the existing project at $4,725,000, or an everage cost of $225,000 per lock and dam; but the cost of the larger ones near the mouth of the river was estimated at $250,000 each. The depth proposed for the slack-water system was 6 feet. In making provision for two locks and dams below Louisa, Congress in the above-mentioned act required their completion for the estimated average cost, whereas the detailed estimate presented in the original plan placed the cost of these lower locks and dams at $250,000 each, and it would be to the advantage of the work if the limit of authority for these two dams should be extended to include the entire estimated cost of said structures.

The detailed survey called for by the act is in reality one of the preliminary steps in the prosecution of the project for general improvement. The information developed by the survey shows that while the flow of these rivers in an average low-water year is considerably greater than it had been supposed to be, yet it is insufficient to supply the entire amount which will probably be needed for lockages, consequently it is not improbable that the upper dams on the forks may be built to advantage as high fixed dams in order that the pools above may have considerable storage capacity. Another fact brought out by the survey is that the desired depth of slack water can be carried up the river to the sill of the existing dam at Louisa by two dams between that place and the mouth instead of three dams, as originally contemplated. For the reasons presented in the report it will be necessary at the first lock of the series to place the sill of the dam high enough for maneuvering purposes during the early part of the low-water season and the sill of the lock low enough to permit of lockages during the latter part of the season. In order to preserve during the early low-water season the chute thus made through the lock it will be necessary to construct guide walls or cribs from the lock itself to the Ohio River, a distance of about half a mile. The cost of these cribs is estimated at $40,000.

The results of the survey of the forks above Louisa indicate that economy can be effected in the locations of the first dams above that point by raising the height of the existing Louisa Dam, as by this means the full depth proposed would be carried to points on the forks where favorable locations and foundations could be found for the two proposed dams next above, and Captain Hodges states that this modification of the Louisa Dam should be undertaken, or at least authorized, if at all, before definite locations shall be fixed for the first dams

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[1] Not reprinted; printed in House Doc. No. 235, Fifty-sixth Congress, second session.

above that point. The cost of the proposed modification is estimated at $35,000. It appears from the results of the survey that the number of dams required for Levisa and Tug forks is the same as that called for in the existing project, but conditions of foundation and of location will undoubtedly render it necessary to vary somewhat the height of the dams instead of adopting for all the average height. For similar reasons some of the dams in the system will cost more and some less than the estimates given in the existing project, but Captain Hodges is of opinion that the entire improvement contemplated in the existing project can be accomplished within the limit of cost hereinbefore mentioned.

Captain Hodges also states that adequate results can not be expected from the series of dams below Louisa until the work of improvement shall have been carried above that place; that the result of the completion of the entire project can undoubtedly be foretold with accuracy by the time 4 dams above Louisa, on each of the forks, have been completed; that it may then be known whether the coal deposits tributary to the river will seek that outlet to market in sufficient volume to justify a continuation of the improvement. It is estimated that these 4 dams will cost $1,015,000 for Tug Fork and $1,090,000 for Levisa Fork.

Attention is respectfully invited to the following remarks made by Captain Hodges in concluding his report, viz:

> For the reasons given above, I believe that a continuation of the improvement of the Big Sandy River and its forks should embrace work as follows, in addition to that already authorized: Regulating works below Dam No. 1; altering Lock and Dam No. 3, at Louisa; continuing work on Dams 1 and 2, below Louisa, in addition to expenditures already authorized; continuing improvement on forks, above Louisa.
>
> An appropriation of $150,000, with authority to continue the improvement by the expenditure of $2,080,000 additional, to be provided by future appropriations, will carry the system far enough to open extensive coal fields, and will finish about half the projected work.
>
> It is desirable that the expenditure of any funds authorized should not be limited to specific objects, in order that any balances remaining from the estimated cost after the completion of individual items of work may still be available for the general improvement.

The opinions and recommendations of Captain Hodges are concurred in by the division engineer, Col. Henry M. Robert, Corps of Engineers.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

Hon. ELIHU ROOT,
Secretary of War.

REPORT OF CAPT. H. F. HODGES, CORPS OF ENGINEERS.

CINCINNATI, OHIO, *November 26, 1900.*

GENERAL: I have the honor to submit the final report on the survey of the Big Sandy River, West Virginia and Kentucky, made under the following provision of the act of Congress of March 3, 1899:

> Improving Big Sandy River, Kentucky and West Virginia: Continuing improvement, fifty-two thousand five hundred dollars: *Provided,* That a contract or contracts

may be entered into by the Secretary of War for such materials and work as may be necessary to complete two locks and dams in the Big Sandy River between Louisa and the mouth of the Big Sandy River, in accordance with the report of April twenty-seventh, eighteen hundred and ninety-eight, to be paid for as appropriations may from time to time be made by law, not to exceed in the aggregate four hundred and twenty thousand dollars, exclusive of the amount herein and heretofore appropriated: *Provided further,* That of the amount authorized to be expended, one thousand dollars may be expended for maintenance on Levisa Fork, and one thousand five hundred dollars on Tug Fork, and twenty thousand dollars, or so much thereof as may be necessary, for a detailed survey of the Big Sandy River and Levisa and Tug forks of the same in Kentucky and West Virginia: *Provided,* That the rest of the amount may be used for the local survey, acquisition of sites, and commencement of construction of the above-named locks and dams.

A preliminary report on this survey was made by me under date of January 10, 1900, and was printed as House Doc. No. 326, Fifty-sixth Congress, first session, and on page 3400 et seq. of the Annual Report of the Chief of Engineers for 1900. This preliminary report described the general methods used in making the survey, and gave the results so far as ascertained at that time. It contained a valuable report of Prof. C. N. Brown upon the mineral wealth of the Big Sandy Valley. Reference is now made to it for information on the points covered, which will not be treated again in this report.

The work on the survey during the present year has been almost entirely confined to plotting the results of the field work which was practically completed in the previous season. One hundred maps,[1] on a scale of 200 feet to the inch, one index map, and three title sheets[1] have been made and accompany this report. In addition a small amount of field work has been done, consisting of current and discharge measurements, leveling to check established bench marks, and making borings at probable locations for locks and dams.

The details of the work of the past year, with a general description of the rivers, of the proposed improvements, and of the probable commerce, will be found in the appended report of Mr. B. F. Thomas, resident engineer, who is in local charge of the survey and of the improvement of the rivers. The report also gives tables giving the bench marks, shoals, discharge measurements, elevations of water surfaces, distances, and water stages. The information given by the discharge measurements is especially valuable, showing, as it does, that while the flow of the rivers in an average low-water year is considerably greater than had been supposed to be the case, yet it is insufficient to supply the entire amount which will probably be needed for lockages. It is, therefore, not impossible that the upper dams on the forks may be built to advantage as high fixed dams, in order that the pools above may have considerable storage capacity.

Besides Mr. Thomas, the following assistants have been employed on this survey: Assistant engineers, C. H. Meeds and A. M. Campbell; junior engineer draftsmen, Paul Hamilton and S. L. Cluett; recorders, John Percival, J. J. Johnson, H. L. Fisher, J. R. Johnson, C. N. Brown, J. F. Prindible, William P. Wiltsee, Homer A. Scholze, Harry C. Corns, and E. O. Young; rodmen, C. D. Boggess, J. C. Butler, W. L. Davies, George H. Walker, and J. H. Turrell.

The general project for the improvement of the Big Sandy River and its forks was submitted by Maj. William H. Bixby, Corps of Engineers, under date of April 27, 1898, and was in part adopted in the legislation authorizing the construction of two locks and dams below Louisa. It contemplated carrying slack water from the Ohio River to Pikeville, on Levisa Fork, and to the mouth of Pond Creek, a short distance above the town of Williamson, on Tug Fork, by the construction of 21 locks and dams in addition to the one now built at Louisa. Of these dams, 10 were proposed for Levisa Fork, 8 for Tug Fork, and 3 for the main river below Louisa. The average cost was estimated at $225,000 per dam for the 21 dams, but the cost of the larger ones, near the mouth, was estimated at $250,000 each. The total cost of the complete improvement was estimated at $4,725,000. The depth proposed for the slack-water system was 6 feet.

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[1] Not printed.

One of the first results of the survey was to show that the desired depth of slack water could be carried to the sill of the existing movable dam at Louisa by two dams between that place and the mouth, instead of three dams, as originally contemplated by Major Bixby. The profile of the Big Sandy River near its mouth is a peculiar one, there being practically two low-water levels, which have to be kept in view in designing works of improvement. In the early part of the summer, when the Big Sandy River itself is at a low stage but the Ohio River, into which it empties, has not yet reached its lowest stage, the water surface and the bed of the Big Sandy River near its mouth have a certain elevation, about 4 feet higher than the same surfaces have later in the season, when the Ohio River has fallen to its lowest stage and the flow of the Big Sandy River has channeled out its easily moving bed. It is, therefore, not practicable to place the sill of the lowest dam of the series at the same elevation as the sill of the lock which affords passage through that dam when raised, for were these elevations the same, either the sill of the dam must be so low that it will be covered by about 4 feet of sand during the early low-water season, in which case it would probably be impossible to raise the movable parts of the dam, or the sill of the lock must be placed so high that navigation through it in the later portion of the low-water season would become impracticable. It becomes necessary, therefore, in the first lock of the series to place the sill of the dam high enough for maneuvering during the early part of the low-water season and the sill of the lock low enough to permit lockages during the later part of the season—that is, at a level 4 feet lower than the sill of the dam. In order to preserve during the early low-water season the chute thus made through the lock it will be necessary to construct guide walls or cribs from the lock itself to the Ohio River, a distance of about half a mile. The cost of these cribs is estimated at $40,000.

The accurate survey of the forks above Louisa indicates that economy can be effected in the locations of the first dams above that point by raising the height of the existing dam at Louisa. This increased elevation will carry the full depth to a point on the forks where favorable locations and foundations for the two dams next above can be found. This modification of the Louisa dam should be undertaken, or at least authorized, if at all, before the definite location of the first dams above Louisa has been made. The cost of it is estimated at $35,000.

The number of dams which the survey indicates as necessary in Levisa and Tug forks is the same as that contemplated in the original project of Major Bixby. Conditions of foundation and location will undoubtedly render it necessary to vary the height of the dams somewhat, instead of adopting for all the average height.

The estimate of Major Bixby that the dams would cost $250,000 apiece on the lower part of the river and $160,000 apiece near the head waters of the forks was unquestionably intended as an average estimate of the cost of the lower dams and of the upper two or three dams of the series. The investigations of the foundations and other natural conditions affecting the cost at the most favorable locations for the lower dams indicate that some of these will cost more than the amount stated and some will cost less, but that the total improvement can be accomplished within the figures named by him.

The object of the improvement of the river can only be to bring to market the immense coal fields which are tributary to the Big Sandy River and its forks. The general trade of the Big Sandy Valley is small—not sufficient to warrant an extensive and costly improvement. The timber trade is large, but the direct effect upon this trade of a system of locks and dams will be injurious rather than beneficial. The numerous coal deposits, which, according to Mr. Thomas's estimate, are sufficient to supply for one thousand years the same amount annually as now comes through Pittsburg, will, however, if fully developed, make ample return for any amount of money which will be spent on the river improvement. Whether these fields will be developed to an extent justifying the completion of the entire project will undoubtedly become manifest before more than half of the proposed works have been constructed.

The first good coal veins on Tug Fork will be reached after the construction of four dams above Louisa. The succeeding dams will add to the amount of coal available on this fork, but will not produce any of markedly superior quality to that reached by the fourth pool. On Levisa Fork the construction of two dams above Louisa will reach good coal deposits, and the succeeding dams will add to the amount available. What is probably the best vein of coal on this river will not be reached until the completion of the entire series of dams.

Congress has already authorized the expenditure of a large sum below Louisa in beginning the execution of the project of 1898 for the improvement of the river and its forks, but no authority exists for continuing the improvement above Louisa. Until this shall have been done no adequate results can be expected from the series of dams below Louisa. The result of the completion of the entire project can undoubtedly be foretold with accuracy by the time four dams above Louisa on each of the forks have been completed. It will then be known whether the coal deposits tributary to the river will seek that outlet to market in sufficient volume to justify a continuation of the improvement. It is estimated that these four dams will cost, on Tug Fork, $1,015,000, and on Levisa Fork $1,090,000.

The limit of authority given by the act of March 3, 1899, for expenditure in the construction of two locks and dams below Louisa was $450,000. The project of Major Bixby, upon which the legislation authorizing these dams was based, estimated the cost of the lower dams at $250,000 each. It will appear, therefore, that the limit now set by law for these works is less by $50,000 than the estimated cost of the work. While it is possible, by strict economy, to construct two locks and dams within the limit of authority granted by Congress, yet it is not possible to do this and at the same time to give to the dams certain features which are eminently desirable for their satisfactory operation. On this account the limit of authority for these two dams should be extended to include the entire estimated cost of the structures.

For the reasons given above I believe that a continuation of the improvement of the Big Sandy River and its forks should embrace work as follows, in addition to that already authorized:

Regulating works below Dam No. 1; altering Lock and Dam No. 3, at Louisa; continuing work on Dams 1 and 2, below Louisa, in addition to expenditures already authorized; continuing improvement on forks above Louisa.

An appropriation of $150,000, with authority to continue the improvement by the expenditure of $2,080,000 additional, to be provided by future appropriations, will carry the system far enough to open extensive coal fields, and will finish about half the projected work.

It is desirable that the expenditure of any funds authorized should not be limited to specific objects, in order that any balances remaining from the estimated cost, after the completion of individual items of work, may still be available for the general improvement. When the work thus outlined has been completed, the result of a continuation of the improvement until the entire project of 1898 shall have been finished can be foretold with accuracy.

Very respectfully, your obedient servant,

H. F. HODGES,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION,
New York, December 4, 1900.

Respectfully forwarded to the Chief of Engineers, United States Army.

I concur in the opinions and recommendations of Captain Hodges as expressed in the within report.

HENRY M. ROBERT,
Colonel, Corps of Engineers,
Division Engineer.

REPORT OF MR. B. F. THOMAS, RESIDENT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Louisa, Ky., November 10, 1900.

CAPTAIN: I have the honor to submit the following report, with accompanying maps and profiles, of the survey of the Big Sandy River, Kentucky and West Virginia, including the Levisa and Tug forks, made under the act of Congress approved March 3, 1899.

On the 30th December, 1899, I had the honor to submit preliminary report covering the field methods, and in a general way describing the rivers. I also included a report by Prof. C. N. Brown on the mineral resources of the region drained by this river and its two principal tributaries, the whole being published as House Doc. No. 326, Fifty-sixth Congress, first session. It will not be necessary in the present report to again cover the points considered in the preliminary report except in a general way.

The present report will be taken up under the following heads: I. Field work; II. Office work; III. Description of rivers; IV. Proposed improvements; V. Prospective commerce; VI. Tables.

I. FIELD WORK.

General.—The field work was practically completed in 1899, and the methods followed were fully described in the preliminary report above referred to. The work done since has been that required to check the bench marks, ascertain the height of the ferry wires, take current and discharge observations, and make borings in the river bed to ascertain the probable depth of bed rock at and near proposed locations of locks and dams. As the work required to check the bench elevations and obtain the heights of ferry wires was simple leveling, no description of it need be given, but the methods of securing discharge measurements and locating the underlying rock may be of sufficient interest and value to warrant explanation.

Discharge and velocity measurements.—The measurements of the current for ascertaining the discharge were made with a Price current meter on the main river and at several points on each of the forks. The instrument was rated by pulling a skiff with a line over a laid-off course in the pool at Louisa just above the dam. Some of these measurements were taken in 1899, but the greater part of them were made in 1900. The stage of water was fairly low, but was probably not at an extreme stage in any case, as the season has not been one of unusually low stages. It may be termed an average low-water season.

In order to make the observations as rapidly as possible, no boat was employed. A sounding rod, current meter, and the end of a 50-foot tape were held by the observer in the water, while the recorder on the bank, with notebook, watch, and the other end of the tape, entered the records. The measurements of the distance to meter from shore and the velocity of water were taken alternately with the distance to sounding from shore, generally at intervals of 5 feet, thus giving approximately the velocity of the water at the center of trapezoids 10 feet long. Where the river was wide, the recorder also entered the water, changing his station each time the 50-foot tape was exhausted.

The velocity measured was the mean for each vertical section.

In this manner the discharge was determined at six points on Levisa Fork and at three points on Tug Fork, as follows:

Dr. Atkinson's, White House, Paintsville, Prestonsburg, mouth of Mud, and Pikeville, on Levisa Fork; and near the falls, Warfield, and Williamson, on Tug Fork.

On Big Sandy measurements were made at Louisa, below the dam.

In addition to the above information current measurements to ascertain the velocity were taken at White House and Buffalo shoals on Levisa, and Wolf Shoal on Tug.

The following mean velocities were found at various shoals:

	Feet per second.
On Levisa Fork:	
White House Shoal	3.0
Buffalo Shoal	3.7
On Tug Fork: Wolf Shoal	4.8

The information obtained will be found in the tables. It does not indicate that pool level can be maintained with daily lockages during the dryest seasons or during the extremely dry portion of the average season, but it is believed that with a dam as tight as that at Louisa it will be possible to maintain pools of sufficient depth for all ordinary navigation purposes throughout the summer and fall and a 6-foot or barge stage the greater part of the time.

The lowest discharge ever recorded in the Big Sandy, and believed to be the lowest stage ever reached, was during the summer and fall of 1897, when it was 48 cubic feet per second. The next lowest measurement ever made indicated a discharge of 100 cubic feet per second, and it is a rare occurrence for it to go this low, and is usually of short duration.

A discharge of 56 cubic feet for Levisa and 63 for Tug was measured in 1899 on a river slightly above the lowest stage reached during the year, which was an unusually dry one. The table shows much greater discharges for low-water stages than the above figures, because the drought the past season has been less severe than in the years before observed.

The observations at Mud Creek and Pikeville were taken upon a freshet, and greatly exaggerate the real discharges for those stages, no doubt. Outside of these two observations, those taken the past season fairly indicate correct quantities for low-water stages, as I think it fair to take this as an average low-water season. There are many years in which the flow continues throughout at from 2,000 to 10,000 cubic feet per second, and few in which the discharge does not exceed 350 cubic feet per second at any time, except possibly a few days now and then.

Prospecting.—A party consisting of a master laborer, eight laborers, and a cook, living on a quarter boat and operating from a push boat 10 by 60 feet, was placed in the field in July to make borings at probable lock sites and other points along the Levisa and Tug forks, the work on the Big Sandy itself having been completed in connection with the location of the locks during 1899. The work was completed early in October.

The method employed was to drive sections of 4-inch iron pipe to bed rock with small hand pile drivers, such as have always been used on this river for driving sheet piling, removing the gravel, sand, etc., from the interior of the pipe from time to time with a sand pump. Two drivers were used, resting on opposite ends of the push boat and projecting over a sufficient distance to bring the "leads" to the place desired when the boat was anchored at right angles to the stream. The pipe was in pieces from 5 to 10 feet long, and as the top of each piece reached the bottom of the driver in its descent another joint was added. The bottom joint terminated usually in a hardened steel shoe. The hammers were of oak, of such weight as could readily be raised by four men, the rope used for the purpose passing over a sheave at the top of the rig. The drivers were light two-story affairs, two men working on each floor. When the bed rock had been reached an ordinary churn drill was dropped into the pipe and used to bore into the rock, usually from 4 to 6 feet, in order to be certain that there was sufficient thickness for a secure foundation, and also to make sure that the pipe had not stopped on a bowlder, loose rock, or log.

After the holes were completed the pipes were drawn with block and tackle, chain block, or jack screws, the joints being detached as they reached the surface.

A diamond-core drill would have been preferable in that the character of the material passed through could have been ascertained, but it was necessary to keep the weight of the apparatus as low as possible in order to float the boat in passing from one site to another, the depth of water in the river often being less than one-half foot. It will be observed that the holes drilled were about 60 feet apart in a line across the stream. When it was desirable to have them closer intermediates were placed in the same manner. Usually from two to four lines of holes were put in at each probable site. When the investigation proved an unsatisfactory bottom to exist, or its probability, additional borings in the vicinity were made, and when the conditions were very unsatisfactory entirely new locations were prospected more or less thoroughly. But little of the information obtained is of as thorough and complete a nature as will be required when the works are to be constructed, because such investigation would involve an expenditure much greater than that permissible with the funds at hand, but that which has been obtained will be of great assistance in making the approximate locations and estimates of cost of the proposed locks and dams.

The site investigation would have been carried forward along with the survey last season but for the fact that it was believed that the completion of the survey would show that dams of uniform lift could be employed. The fact that the drilling apparatus and boats were already in use below Louisa also had its influence in delaying the work.

It was believed that the works could be located at or near the points which would be indicated by the final profile as desirable for dams of uniform lift, considering only the elevations one above another. That this supposition was not wholly correct is now apparent, and it is thought that geological formations will govern the location much more frequently than will the fact that any given point is the proper vertical distance above any other given point. Instead of all dams having a uniform lift, it is probable there will be a few of greater or smaller lift, and that the locations will be determined largely by considerations of economy and permanency in construction. The first step in securing this economy and stability is to build upon rock foundation; the nearer this is to the sill level the greater the saving in expense. It is one of the characteristics of these rivers, however, that the rock shows most frequently in pronounced bends, and as such points are unfavorable for ingress and egress it will not always be practicable to locate the locks at places having the best foundation. Each location must form a study of itself and the final site be determined after all the points for and against its competitors have been carefully considered, and it will not be necessary to enter fully upon this until the time for actual construction is within reasonable distance.

The progress of invention, experience with other dams now in operation or about to be completed, the tendency by speculators to buy up and hold for high prices the land required, and many other considerations conspire to render it inadvisable at this time and in this public report to definitely fix the locations of any of the locks and dams in the systems proposed, even if it were practicable. It is necessary that those in charge have an approximate idea of the several locations, and that they be informed within certain limits as to the probable cost and general features of the various works, but it is not practicable, with the incomplete information obtained, and without further investigation more in detail, and a more complete study of each case, to definitely locate each of the locks and dams with that intelligence and care which should be exercised in the location and prosecution of works of such magnitude and importance.

Cost.—The expense of the survey was as below:

Equipment	$3,335.55
Surveying	10,706.86
Boring	907.09
Gauging	83.93
Subsistence	2,225.12
Office work	2,294.31
Total	19,552.86

II. OFFICE WORK.

Platting.—Much of the line was platted on roll paper in the field as fast as run, and on some portions buildings, fences, roads, streams, etc., were located. Upon completion of the survey these maps were carefully checked and additional details of topography were put on and tracings made. The scale used is 200 feet to 1 inch.

Maps.—The total number of maps pertaining to the survey is 100, with 1 index and 3 title sheets, divided as follows:

	Sheets.
Big Sandy River	18
Levisa Fork	51
Tug Fork	31
Index and title	4

The size of the sheets inside of border is 25 by 38 inches. These maps were all traced from pencil copies. It is the intention to make ink originals later on, if the funds are sufficient for the purpose, for file in this office. These will show contour lines and other information of use in locating the works of improvement.

One complete set of blue prints was made for your office and one for this office; also two sets to accompany your report.

The work on the maps was all done by hand. The Ockerson lettering device was too small to hold as many letters as desired. This is a serious disadvantage of this otherwise excellent device; and had I known that it was so small, it would not have been included in the requisition. The same objection to it has been raised many times before, but this discovery was not made by me until the device was delivered. The time it takes to dry the ink on tracing cloth is also a serious drawback to its use.

Profiles.—A profile of each river on plate B paper, scale 400 feet horizontal and 30 feet vertical, has been made and traced. These show extreme low-water-surface and river-bed lines taken at each cross section. The river bed is too unstable for these to be of much real value in the future, particularly in the lower portions of the streams where sand abounds, except as general profiles showing the location of shoals and principal elevations. Each rise changes the profile of the bottom, filling in here and cutting out there. There are, however, many pools which remain practically constant.

Photographs.—In order to show the scenic features of the rivers, photographs have been made in a number of localities. There is nothing particularly striking or attractive in the general landscape, but here and there beautiful combinations of land, water, and sky may be obtained to relieve the monotony of gray sandbars and furrowed hillsides. When the leaves are turning, in October, many of these views are charming to the eye, but the varied hues can not be transferred to plate by the camera nor pictured by pen.

Datum.—The plane of reference for the levels was taken at the Ohio River bench mark at the Big Sandy National Bank at Catlettsburg, the elevation of which is 549.088. This elevation was not known until October 22, 1899, when all elevations on the survey which had been previously recorded were corrected to agree with it. Its description is as below:

Cut on top of stone foundation under window at left of office entrance on Division street of Big Sandy National Bank, Catlettsburg, Ky., situated on the southeast corner of Division and Louisa streets. Bench mark is 58 feet south of Louisa street curb line and 11.25 feet north of south corner of building. Bench mark marked thus:

B
U ▭ S
M

The curb line has since been changed, the distance now being 60 feet.

Bench marks.—Temporary bench marks were established on trees and other fairly permanent objects at the time of running first levels at intervals of about 1 mile. Upon the final survey regular bench marks intended to be permanent were put in at about 2-mile intervals. A list of these, with descriptions, will be found among the tables. They consist of an iron pin set with cement in the center of a flat stone about 10 inches thick and 18 inches square, sunk some 3 feet into the ground. A galvanized-iron pipe leads from the stone to the surface and is closed at top by a cap or cover upon which is cast the number of the bench mark. By removing a set screw the cover can be taken off, and access to the pin can be had with leveling rod.

These benches were set at points easily found and at the same time not where they are liable to be disturbed by the curious, animals, teams, etc.

Former surveys.—By act of June 23, 1874, the Big Sandy and Levisa below Piketon and Tug below Warfield were ordered surveyed. This work was done under the direction of Maj. William E. Merrill by James E. Bell, assistant engineer. An approximately correct outline of the streams was obtained by running lines through the bottoms and offsetting to the river, and levels and soundings were taken with sufficient accuracy to obtain an approximate profile of the river bed. A fairly correct map and an excellent report were made by Mr. Bell.

A survey of the Tug fork from Louisa to the Roughs, 100 miles, was made by J. C. Thomas in 1884, in connection with the snagging operations on that stream. This survey cost but $500 and has proved accurate and complete in every feature. The map and profile have done excellent service in connection with the improvements carried on. The object of both of these surveys was mainly to obtain data for making a map of the rivers with a view to locating and deciding upon the improvement works desirable later along, and, while they were not elaborate or expensive, they have served the purpose very well up to the present time.

III. DESCRIPTION OF RIVERS.

General features.—The Big Sandy River is formed by the junction of the Levisa and Tug forks, at Louisa, Ky. It flows in a northerly direction to the Ohio, about 27 miles, at Catlettsburg, Ky. It is the division line between the States of West Virginia and Kentucky.

These tributaries have their sources in Virginia. That part of Levisa surveyed below Pikeville, Ky., is 88½ miles long, and that part of Tug surveyed below Pond Creek is 58 miles in length, making the total length of survey, including the 27 miles of Big Sandy, 173½ miles.

The Levisa Fork flows northwesterly to Prestonsburg, Ky., where its course changes to northeasterly, while the Tug keeps a northwesterly course and forms the boundary between the States of Kentucky and West Virginia.

The average width of the Big Sandy at mean low-water level is about 300 feet, and it is about 500 feet between tops of banks. Levisa and Tug are, of course, considerably smaller, the former being about 350 and the latter about 300 feet in width between tops of banks. The banks are usually sandy and unstable, and the bed is sand, except in the upper portions of the two forks, where some gravel is found.

Slope and bed.—The Big Sandy itself has no shoals. The slope of its bed is nearly uniform from a point 1 mile above its mouth to Louisa. The lower mile is very steep, and its slope varies greatly with the stage of water in the Ohio, being reduced at high stages by the deposit of sand, and increased when the backwater recedes by the cutting out of the deposit. The average slope of that part of the river above the Chesapeake and Ohio Bridge (situated 1 mile above the mouth), is nine-tenths of a foot to the mile. The average of the entire river is 1.16 feet per mile. On Levisa Fork the total fall between Pikeville and Louisa is 116 feet, an average of 1.3 feet per mile. There are about fifty shoals and ripples in this part of the river, but most of them are of no importance, particularly in the lower portion of the stream. When the survey of 1875 was made there was considerable fall at nearly all shoals, but the pools between them have filled with sand, and some of the shoals have been gradually cut down in the removal of rocks from the chutes until now they are little more than ripples, and do not show except in extreme low water.

Tug Fork falls 102 feet below the mouth of Pond Creek, an average of 1.76 feet per mile.

The river has 46 shoals, some of which are ascended with considerable difficulty in the low-water season; in the lower portion of the stream the survey of 1875 showed several which are now buried out of sight in the sand.

Character of commerce.—Considering the shortness and uncertainty of the navigable periods these streams carry a remarkable quantity of commerce. This is largely in saw logs, cross-ties, and staves, but there is also considerable live stock, poultry, and produce sent out of the valley by water. It is not upon this commerce, however, that the people must rely for their wealth and support, but upon that to be developed by the advent of slack water, the opening up of the vast coal deposits found in almost all sections along the rivers and their tributaries. The accessible quantity of workable thickness and merchantable quality is variously estimated at from 3,000,000,000 to 10,000,000,000 tons, an amount so enormous as to not be readily understood by a simple reading of the fact. The shipment of coal from Pittsburg by the Ohio River will average about 3,000,000 tons per annum. The minimum quantity estimated in the Big Sandy region would supply this trade for one thousand years, or it would supply the entire river trade of the Ohio Valley, including the coal taken out of the Great Kanawha and other streams for over five hundred years. This statement is made here because of an error in the preliminary report which estimated the Ohio shipment from Pittsburg at 6,000,000 instead of 3,000,000 tons. The latter quantity is greater than the average for the past twelve years.

Navigation.—As will be noticed in the discharge reports there is not sufficient flow for constant navigation on either of the three streams surveyed. In addition to the lack of water may be mentioned the obstructions which constantly form in the sandy bed. These obstructions are much more numerous because of the sandy character of the banks, which are easily undermined, and thus whole trees are thrown into the channel with their roots and branches intact. An attempt has been made for several years to remove these obstructions during the low-water season, and it has been fairly successful, but the funds have usually been insufficient for complete and perfect maintenance. Another cause of the shortening of the navigation season and probably as effective as any other, if not the chief difficulty, is the tendency of the river bed to pile up in sand bars covering the entire width of the stream. It is not practicable to maintain a low-water channel in such a formation, the water spreading out over the whole bar in a sheet barely covering it. This is particularly troublesome in the Big Sandy itself and in the lower portions of the two forks. The length of the navigation season varies greatly. Some years boats may run every month, while others the time is reduced to three or four months in the winter and spring. In the Big Sandy the season is, of course, much longer than in either fork, and in the forks Levisa usually has navigable water considerably longer than Tug.

The character of boats employed for general traffic is a light-draft, side-wheel, flat-bottom, single-deck affair, about 120 feet long and 18 feet wide, with a carrying capacity of about 50 tons. Their draft is from 12 to 24 inches. There are, however, a few better boats—stern-wheel, 120 to 140 feet in length, from 20 to 25 feet in breadth, and carrying about 100 tons, with a draft of 3 feet. In addition to these, towboats 120 to 130 feet in length make trips with barges of staves, tanbark, spokes, etc., during times of sufficient water, and push-boats operated by men run during low-water periods. The latter are usually about 8 feet wide and 75 feet long, and when loaded usually have a draft of less than 7 inches.

The total number of boats navigating these streams has varied with the amount of commerce and length of time of navigable water. There are usually about a half dozen regular boats with now and then a few months with more. There are generally at least two regulars run in connection with the Chesapeake and Ohio Railway between White House and Pikeville. There is a line of three or four plying between Catlettsburg and Paintsville, with occasional trips to Pikeville, and a large boat or two between Catlettsburg and Pikeville. There is also a boat between Louisa and the Ohio and a boat or two running up Tug Fork from the Ohio.

Regulating works.—In Major Merrill's report on the survey of 1875 is the following: "It is evident that the only feasible way of procuring a sufficient supply of water for navigation, and especially for a navigation by coal barges, is to canalize the river by means of locks and dams. In doing this we at once have our choice of two methods—the French method, recently invented, of movable dams, and the method in use on the Monongahela, Muskingum, Kentucky, and other rivers, of permanent dams. The first method is decidedly the better of the two where the natural navigation lasts for several months continuously, but its greater cost of establishment and of maintenance naturally causes the selection of the second method for rivers on which the total amount of navigation is not great. * * * Mr. Bell's report shows that in many places the bed of the river is full of large bowlders that should be removed. It is also full of snags, and the banks are encumbered with inclining trees. A good work can undoubtedly be done by removing these bowlders and snags and cutting down the inclining trees. * * * If Congress should be unwilling to appropriate sufficient money for the construction of a complete system of slack water, or if money were only appropriated for one or two locks, it would still be a very great advantage to navigation to have the bowlders and snags removed."

In accordance with the latter recommendation, a project for the removal of obstructions was adopted in 1878 for Big Sandy, and in 1880 for Levisa and Tug, and on June 18, 1878, $12,000 was appropriated for the purpose. This was supplemented later along by numerous appropriations of small amounts for the work and for maintaining that already done. In addition to this the State of Kentucky had previously constructed some wing dams and other regulating works.

The project was modified in 1880 by authorizing the construction of a lock and dam at Louisa, in the Big Sandy, and this has been completed and was put into operation in 1897. Two other locks and dams have been authorized between Louisa and the Ohio River, and their construction will be entered upon soon.

It will be seen from the foregoing that the improvements so far made are almost wholly those of obstruction removal and regulation by the construction and maintenance of walls, dikes, and wing dams. These are all of inferior character, and are usually made by piling up in ridges the bowlders removed from the shoals. They are very helpful to navigation and extend its season materially, but of course can not be a permanent benefit or furnish sufficient depths for a continuous navigable season. It is expected that this can be secured by the carrying out of the system now inaugurated, which contemplates the construction of locks and dams in all those portions of the rivers included in this survey. Some of the more important regulation improvements which have been made from time to time by the State of Kentucky and the General Government are enumerated below. The walls mentioned were generally loose bowlders piled in ridges, and the banks and bed have filled in behind and over them frequently until they can scarcely be distinguished. No attempt has been made to show them on the map on this account. For clearness they will be mentioned on each fork separately, beginning at the mouth. There have been no such improvements on the main river. On Levisa Fork they are as follows:

A wall was built on the west side, at Bumble Bee Shoal, 250 feet long, 6 feet wide, and 3 feet high. This shoal has disappeared.

At Chestnut Shoal walls were built on each side of the chute, 300 feet long, 6 feet wide, 4 feet high, and many large rocks were blasted out.

A wall 350 feet long, 6 feet wide, and 3 feet high was built at Little White House Shoal on the west side, and a number of large rocks were removed.

At White House Shoal walls some 800 feet long, 10 feet wide, and 5 feet high were built on each side the chute. The State also built some small walls here. This was formerly one of the worst, if not the worst, shoal on this fork, but is now not a serious obstacle to navigation, although needing more work done.

At Wild Goose Shoal about 500 feet of wall has been built on the two sides of the chute.

Greasy Shoal has walls on each side of the chute about 600 feet long, 9 feet wide, and 5 feet high.

Buffalo Shoal is three-quarters of a mile in length and has a wall on each side, averaging 8 feet in width and 4 feet high. An old milldam was removed hère by the State. While this shoal is much easier passed than formerly, it is still the worst shoal on the river and needs much more work done on it. It has a fall of 5 feet.

A wall 600 feet long, 9 feet wide, and 3½ feet high was built on the west side at Hells Gate Shoal.

At Devils Drawbars Shoal there is a wall 350 feet long, 6 feet wide, and 3 feet high on each side the chute.

Hager Shoal has about 400 feet of wall 6 feet long and 3 feet high.

At Wiremans Shoal a wall 700 feet long was built on the east side of the chute.

At Moody George Shoal, a flat, shallow place, the State removed some large rock and the Government has built a wall along the west shore 500 feet long, 7 feet wide, and 4 feet high.

The State also did considerable blasting at Abbott Shoal and put in a wall on the east side. The Government also built a wall 450 feet long. This was formerly a very swift place, but is now quiet.

Prestonsburg Shoal is long, flat, and shallow, and has about 600 feet of wall on each side.

Sugar Loaf Shallows was once about three-quarters of a mile in length, but has been pretty well cleaned and improved. It has no walls.

At Robert Hall Shoal there is 300 feet of wall, and at Prator Shoal there is 500 feet.

Grimes Shoal has a large wall on the west side 700 feet long and on the east side about 400 feet.

Long Shoal is about three-quarters of a mile in length, and has a wall 3,960 feet long, 8 feet wide, and 4 feet high.

This completes the list for Levisa below Pikeville.

There are many places not named where large rocks have been blasted out and other important work done, but the object here is to mention only those works which stand out prominently in the general system. These various works have been fairly well maintained, the rock cleaned out of the shoals having been piled up on the walls or used to repair breaches therein or sometimes to build cross walls between the guiding walls and the banks.

On Tug Fork the following-named places have been improved with works worthy of mention.

At Lost Creek a ledge of rocks was blasted out. This ledge was along the east side and in the concave bank and formed a serious obstruction.

At the Falls, 10½ miles above Louisa, the State of Kentucky did considerable work in blasting out rock and rendering the river navigable. Later the Government blasted out some very large rocks. The Falls, which by Mr. Bell's survey in 1875 showed about 3½ feet fall, are now virtually level.

A wall 280 feet long, 5 feet base, and 3½ feet high was built on the west side at John Smith Shoal.

At Whitt Bar Shoal a wall was built on the east side 525 feet long, 10 feet wide, and 6 feet high.

Along the west shore at Turkey Shoal the wall is 450 feet long, 6 feet wide, and 3 feet high.

At Crums Milldam Shoal considerable work was done by the State and later by the General Government. The wall along the east side is 650 feet long, 10 feet wide, and 5 feet high.

Silver Creek Shoal has a wall 200 feet long, 6 feet wide, and 3 feet high. The chute has been moved from the west side to the center of the river.

Lick Shoal has a wall along the east side 600 feet long, 7 feet wide, and 4 feet high.

Marrowbone Shoal was formerly a very bad place, but is now very easy to pass. The wall on each side is 200 feet long. A great deal of work has been done here, particularly the blasting of some large rocks.

Buck Creek Shoal is just below Warfield. It was formerly a steep shoal, but is now, by constant work, in good condition. The wall on its east side is 650 feet long and on its west 500 feet.

Probably the worst shoal on the river is Wolf. It is one-half mile long, with nearly continuous walls on each side. On the west side 3 walls have been built and on the east side 2, with a total length of 4,600 feet, with 10 feet base and 6 feet height. Much more work could be advantageously done here. It has a fall of about 7 feet.

Above Wolf there are several small shoals, with walls aggregating 1,860 feet in length.

Long Branch Shoal is a long, winding, rocky shoal, with 1,250 feet of wall on its two sides.

Carter Ripples has a wall on each side 185 feet in length.

Pigeon Shoal has a wall on each side 580 feet long, 10 feet base, and 5 feet high.

White House Shoal has a wall 275 feet long; Granny Starr, 450 feet in 2 walls; Mount Sterling, 479 feet; Coleman, 675 feet; Big Creek 475 feet; Jim Taylor, 550 feet, and Persimmon, 375 feet.

Alley Island was improved by changing the channel from the west to the east side and closing the old chute—a great deal of work. A wall was put in on the west side 790 feet long and on the east side 375 feet.

At Sugar Tree Falls there is 650 feet of wall on the two sides, and at Pond Shoal 275 feet.

There has been a great amount of work done in shoals and at other points not named, for example, Copley Shoal, Twisting Shoal, Endicott Ripples, Calf Creek Shallows, Bull Shoal, Big Elk, Jennies Creek, Joe Dempsey Shoal. Buffalo Shoal, Little Hi Williamsons, Grapevine Shoal, etc.

The object has been to mention only those places of most importance and best known to navigation interests.

IV. PROPOSED IMPROVEMENTS.

General considerations.—The improvement of a river calls first for the removal of those things which obstruct navigation, and second, for the construction of permanent works capable of securing and maintaining a fixed navigable depth of water. In addition to these the banks must be protected from erosion or caving, the leaning timber must be cut away and channel obstructions must be removed from time to time as they form or are exposed by a change of current. In their original or natural condition rivers, as a rule, are not navigable; fallen timber, overhanging trees, projecting rocks, and diverted channels render navigation unsafe and impracticable, and these obstructious must be taken out before even a fair condition for communication can exist, and much more than the simple removal of natural obstacles is generally required before a river can become of full benefit for the transportation of the people and products of a country. The water supply becomes reduced during the dry season and must be hoarded in pools or confined to narrow limits in order to maintain a sufficient depth for commerce, and during the rainy season its volume is greatly augmented and adjacent lands inundated.

The accumulation of sediment and the splitting up into several passes or crooked chutes, forming towheads and islands, often render portions of streams otherwise navigable dangerous for craft. We have under study here one short, shallow, narrow river, with sandy bed and unstable banks, and two long rivers (from which the short one is formed), with similar characteristics, at least, in their lower portions. These streams go almost dry in the fall season and are swollen to heights of from 25 to 50 feet in the spring. At flood times trees are torn from the banks and lodge in the sandy bed, to become obstructions to navigation or a nucleus around which is soon built up a towhead, and large areas of the banks are cut away and washed into the channel. In winter heavy ice is formed, only to be broken up by a sudden melting of the snow on the adjacent hillsides and carried on a raging torrent out of the river, leaving destruction everywhere in its path, not even neglecting the walls of shoals or the wing dams at bends placed to aid navigation. The problem for decision is how best to remedy these evils and put the rivers in the best possible condition for permanent and continuous navigation. There are no theoretical or practical rules to guide us to reliable conclusions. Experience itself is of little more value because of its contradictory results. It is plain that a method of improvement having for its object the collecting and discharging of a large surplus quantity of water during flood time may also defeat the ends of navigation during droughts; or, on the contrary, a system which will afford ample water for navigation at all times may also be the means of destroying valuable property and cause untold misery and loss during excessive floods.

The same principles are not applicable to all streams or to the whole of the same stream, and we might with consistency design ample regulating works for the Big Sandy and the lower portion of the forks, movable dams for the mid sections of the forks and fixed dams for their upper portions, with finally a simple cleaning of the channel to accommodate light traffic farther up. In solving this problem it is only necessary to consider two methods of improvement—regularization and canalization. The method of snagging and cleaning has been in use for over twenty years, and while it is of very great benefit, yet it is only to be considered as a method for temporary relief. Regularization, or open-river navigation, has for its object the provision of sufficient navigable depths on bars by means of guiding and contracting works along shore or in the river bed. Canalization furnishes sufficient draft of water by means of dams built at intervals, the pools from which are connected by locks.

Works for the improvement of the natural navigation include the fixed establishment of the channel within certain limits, the regulation of its curves and tangents, and the maintenance of its bed at a level which will produce the desired draft for navigation. In a general way, it may be stated that the removal of bars is accomplished by the contraction of the channel at the desired points, and thus, by an increased force of the current, to carry away the material composing the bar. The contractions are effected by means of dikes built out from the shores or nearly parallel to the shores in the vicinities of the bars. The method is very popular in Germany and is used more or less in all countries. Its greatest advantage is that there is no stoppage to pass through locks, but it is rarely satisfactory, from the fact that it fails to maintain the required depths for navigation during the dry season, even in rivers of large discharge.

In rivers similar to these now being studied, however desirable it might be because of its low cost, its failure would be certain if for no other reason than the lack of water during a great portion of the year. Eminent authorities have agreed that the result to navigation from the simple removal of obstructions and confining of channels is not usually sufficient, and have pointed out that, instead of reducing the shoals found in rivers, they should be preserved at their normal height in order to maintain the original pools, and, in addition to this, erect works across the stream which will afford the desired depth over the bars themselves, and, at the same time, reduce the current velocity, a double advantage to navigation. This is called canalization, and is what is proposed for the Big Sandy, Levisa, and Tug rivers. The means proposed to accomplish this are dams for ponding and conserving the water and locks by which the dams may be passed. From an engineering standpoint this is the only proposition which offers even a fair chance of success, and, while it is costly, I feel certain that the expense will be amply justified by the amount of commerce which such a system will be the means of developing, and will not be out of proportion to the results realized. Having decided on locks and dams, it is necessary to make a further decision as to whether the dams shall be fixed or movable, or whether there shall be some of each class.

In the Big Sandy itself and in the lower portions of Levisa and Tug there is so much sand traveling in all rises that it is believed dams of the fixed type would have a tendency to fill up and thus endanger navigable depths. There is no disposition to do this with movable dams, as they are usually down during rises of consequence, and the river is allowed to resume its normal condition. Another thing—should the inauguration of slack water be followed by a large development of coal it would be a great detriment to navigation to have to pass every barge through the locks, winter and summer, as would be the case with fixed dams. It is therefore considered much safer and better to adopt movable dams in the main river and the lower portions of the forks, with the probability of their adoption in the upper portions as well, the final decision of the latter to be left open until it becomes necessary to decide it, and until time and experience have demonstrated what the commerce is liable to become and how the dams, as built, meet the requirements.

Project.—In the project recommended by Maj. W. H. Bixby, Corps of Engineers, April 27, 1898, it was proposed to have three locks and dams in Big Sandy in addition to that at Louisa already in operation, ten on Levisa, and eight on Tug, a total of twenty-one. This project contemplated the improvement of the lower part of Big Sandy by a lock and dam of low lift built as near the Ohio as practicable. This plan has been modified by substituting two high-lift locks and dams for the one low lift and two medium lift, and a system of dikes below Lock No. 1 for contracting the waterway in order to reach the Ohio during the season of extreme low water. The plan for the two forks remains practically as submitted—ten locks and dams for Levisa and eight for Tug, with a possibility of reducing the number to nine on Levisa by a slight increase in lift of some of the dams. It is, however, probable that the lift will have to be reduced in places in order to secure an economical and desirable site upon which to build, and that it is not safe to count on less than ten locks and dams for Levisa. In addition to this the Louisa Dam should be modified so as to meet requirements dictated by experience, and be slightly raised. * * *

Location of works.—The authority for contracting having once been given, and the funds for prospecting and purchase of sites having been provided, it will be necessary, next in order, to determine upon the locations of the locks and dams. In doing this there are many things to be considered. When the river bed is pretty generally rock the location will naturally be made in some reach or stretch of straight river, far enough from a bend, either above or below, to make the lock easy of access, or when the dam is down to make it safe to pass the works under full head of steam. Due consideration will be given to the hydrostatic conditions, because each pool is limited by the horizontal plane passing through the crest of the dam and continued upstream till it meets the natural slope of the water or connects with the next dam at a level previously determined upon. This plane must reach not only the required depth on the sill of the next lock, but also upon all points or obstructions between the two dams, unless they are to be dredged out. The actual slope of a pool at normal height is too slight to take into account in determining the location. It varies as the discharge of the river increases. It must be considered, when stationary dams are to be built, for its effect upon adjacent lands and industries in neighboring streams. The height it will then attain during floods is often of great importance. In movable dams the case is different, because the dam is lowered upon the approach of floods, so that the river has resumed something near its natural condition before the water has reached much above the ordinary pool level.

Bed rock will not always be found at the point indicated by the profile as the proper location for a dam of a certain fixed height, and it will be necessary to determine whether to build upon the foundation found, whatever its character, or shift the site to a point where a good bed rock can be had. It is expected that the dams on the rivers under report will be of unusual lift, and it is advisable to take the utmost precautions to prevent leakage and undermining and insure stability. The first consideration, then, will be to secure a solid foundation upon which to build, and the second to find this foundation in a part of the river straight enough to enable craft to pass the works without difficulty when built. A third consideration will be to find the bed rock at as small depth as practicable below sill level. It is not probable that all these conditions will be fulfilled at all the sites, or even at a majority of them, but by varying the lift of the dams, increasing a foot or two here, or decreasing a foot or two there, it is believed that fairly good sites can be obtained upon which safe and economical construction can take place.

It may not be amiss to sum up the considerations which should ordinarily control the location of locks and movable dams in rivers similar to these:

1. A good foundation upon which to build, deep enough to prevent shoaling below and provide sufficient depth for anchorage, but not deep enough to make it difficult to reach and expensive to build upon.
2. Banks at least of the average height of those along that part of the stream, and of firm material, such as clay, rock, etc., not easily cut away or overflowed during floods. This should particularly be the case at the abutment end of the dam.
3. A straight channel for some distance above and below the lock; that is, the location should be near the middle of a long stretch of straight or nearly straight river.
4. Sufficiently level or nearly level land on the lock side of river upon which to erect the necessary buildings for construction and operation and to form a yard for piling building materials.

5. The lock should, when below a pronounced bend, be placed on the convex bank in order that the drift will naturally run as far from it as possible. The lock will be less easy of access and more liable to sand up in such locations, but these drawbacks are, I think, not equal to those arising from placing the lock in the concave bank. In such position, timber rafts, which usually run when the dams are down, strike the outer lock wall and are frequently damaged, and, as has been said, drift constantly runs into the lock, even with the drift chute on the abutment side open. It is not practicable to place the drift chute next the lock wall because the escaping water and débris will hinder entrance to the lock from below and endanger it from above.

For reasons of economy in construction it may sometimes be necessary to place the lock in the concave bank, because, as a general thing, that bank has a rock bed near the surface, while on the opposite shore it may be very deep or missing. It is, of course, much more economical to build the lock on a shallow foundation and the abutment on a deep one than it would be to reverse the order.

Fixing sills and depths thereon.—The depth of the pass sill below low water will be decided upon according to the mean position of the river bed and depth desired. It should not be higher than the line connecting the crests of the bars above and below it. If so, it becomes an obstruction itself at the stage just previous to that at which the dam is to be raised and at times when the lock is out of service, a condition quite common during the winter and spring, because it is not always advisable to raise the dam when the low stage approaches on account of the probability of ice or a rise within a short time. Neither should it be lower than the line connecting the bars above and below, or the tendency to sand up will be increased. It would seem, therefore, that its proper position is on that line. There is no good reason why the rules governing the fixing of the pass sill should not also apply to the lower sill of the lock if the bars above and below be of a fixed character; but with the idea in view that these obstructions may be removed by natural causes or drèdged out, lock sills are frequently placed some inches lower than pass sills. The objection to sanding up is not so serious here, as the valves of the lock may be brought into play and wash the material away.

In arriving at a decision as to the minimum depth which should be given a system of slack-water improvements it is most natural to ascertain the draft of the heaviest craft when loaded to the water line and then add to this a reasonable amount for clearance. The amount of the clearance may vary from 6 to 12 inches. On rivers like these under consideration, which have small low-water discharges, it is not always possible to maintain full pools throughout the summer and fall, and a larger clearance will have to be allowed on this account. Another consideration which should not be overlooked is the probable requirements of future commerce which may be developed by the slack-water system. The present commerce of these streams would be admirably served with 4-foot navigation. Its future may demand an 8-foot stage. Experience on the rivers of France has amply demonstrated the folly of providing an insufficient depth to begin with, for it was finally secured only at much greater cost and inconvenience to navigation, to say nothing of the effect the alterations produce upon the appearance of the works themselves. Recent attempts have also been made to secure legislation looking to an increase in the navigable depths on Ohio River dams to 8 feet instead of 6, as at present projected.

It goes without saying that an increase in depth means an increase in cost, and the question arises whether the benefits to be derived from greater navigable depths will justify the expense required to obtain them. The rivers under consideration are narrow and crooked, and it is not probable that barges loaded to an 8-foot depth will ever become popular; it is even doubtful if those drawing 6 feet will be fully satisfactory. It is more probable that the Pomeroy barges, 20 by 100 feet by 5 feet 6 inches, and loaded to draw 4 feet and carry from 7,000 to 8,000 bushels of coal, will be more frequently seen in tows of three or four than will those of the character now in use on the Upper Ohio and Great Kanawha. It would seem, therefore, considering the size and character of these streams and the expense required for inaugurating the improvements, that in providing for a minimum depth of 6 feet on the sill when the pools are full due consideration has been given to the interests which will be engaged in developing and transporting the future commerce, while the present navigation interests will be able to do the business with larger, better, and fewer boats at less cost than in the past.

Lift.—In the determination of the lift or vertical height from the normal level of the lower pool to the normal level of the upper pool there are no bridges or water-power mills in creeks near by to be considered and but little regard need be given riparian property, as, generally, it will be above the level liable to be chosen. If navigation alone were to be consulted, then the fewer dams the better, within certain limits, because each is an obstruction which causes more or less delay to transportation and inflicts more or less injury to craft, to say nothing of the risk to life and property. This principle will also apply so far as expense is concerned, because the cost of the additional height is nothing approaching that of the same height in a new structure by itself. But even with banks of sufficient height navigation alone can not be consulted in the decision of this matter. The sizes of the parts to be maneuvered must not go beyond the power to be applied in the maneuvers; the effect which turning loose a great volume of water will have on the works themselves and the banks below and the pressure exerted upon the material upon which the dams are built and consequent leakage and danger from undermining or cutting around must be considered, and, lastly, the effect such danger will have upon the regimen of the river, whether it will not cause shoals or bars which will become obstructions, must not be omitted in the study.

In the settlement of this question it is natural to revert to what has been done in the past. In France, where the dams are practically all movable, the lift is generally small, although the later dams have been increased considerably. In this country less than a dozen movable dams do not exceed 14 feet in height, with a lift of 7 or 8 feet. There are many stationary dams with lifts of over 16 feet. When the bottom land is high and the banks of firm character, there seems no reason for these low-lift movable dams. With proper precautions in the construction and design it seems entirely feasible to greatly increase the lift. This will, of course, reduce the number of works and, in consequence, the cost of the system. It will be much less expensive, for instance, to overcome a certain height with 8 dams having 12 feet lift than with 12 dams having 8 feet lift, because the cost of the foundations and walls is practically the same for the low-lift locks and dams as it is for the high-lift locks and dams, and these are the chief items of expense. The superstructures of the dams are comparatively inexpensive, and the expense does not increase rapidly with their height. The chief difficulty in deciding upon an increased lift for this system over that now in vogue elsewhere lies in the lack of precedent. Were the banks and beds of these rivers of solid rock, or even a good gravel, the problem might be approached with more assurance of success. As it is, with sandy bottom and rotten banks, the chances of success are lessened, but there is no prospect of failure if proper precautions are taken in designing, constructing, and operating the works.

The dam at Louisa is 13 feet in height. Owing to the fact that the next dam below has not yet been built, the low-water season leaves 12 feet of a head. The dam is operated without difficulty, and has led me to propose that the new dams have a lift of 12 feet and a height of 18 feet. It will probably be necessary, in order to secure proper locations, to sometimes increase or decrease this slightly, but I think this can be adopted as the general lift to be given the dams on these streams. The locks on the Big Sandy below Louisa have been planned with this idea in view.

Locks.—The rule usually followed in adopting the dimensions of a lock has been to make them slightly greater than the largest vessel navigating the river. This has been varied on streams having considerable towage to admit a certain number of barges, and on timbered streams to allow rafts of certain dimensions to pass. The tendency has been and still is to increase the length and width, so that larger tows may be accommodated and time saved. Very few old locks have been enlarged in this country, but when new ones have been built, even on rivers having small locks, larger ones have almost invariably been put in. In France many locks have been torn down and rebuilt with greater capacity, some of them having recently been completed. This is very expensive work, and it will be better to build larger than present commerce justifies if it is probable that future navigation will demand better facilities.

For the present navigation of the rivers under consideration locks one-half the width of that now in use at Louisa would answer every purpose, because they would accommodate the boats plying the streams. The timber rafts need not be considered, as they almost invariably run when the water is too high to have the dams up, so that they do not pass through the lock. This condition will, however, be modified when the whole system is completed, because then there will be sufficient water all along in summer as well as winter, but it would be no hardship to adapt the rafts to the size of the locks. The present commerce, then, may be left out of consideration in determining the dimensions to be given the locks, and only that to be developed by reason of the slack-water system need be taken into account. It is believed that this will be almost wholly coal in barges, moved by towboats. The dimensions of these barges will vary from the Pomeroy barge of 20 by 100 feet to the Kanawha boats of 26 by 136 feet, with the possibility of occasional boats of slightly greater dimensions coming in from the Pittsburg field. It will be desirable to lock two barges or a barge and towboat abreast, and some allowance for clearance must be made. Experience on the Kanawha has led to the adoption of 55 feet as the width. The length may be made for one barge, for towboat or packet, or it may be for two barges end to end.

In those already designed for the Big Sandy the length has been made sufficient for the longest towboat and for an ordinary raft it being probable that the timber interests will use the lower part of the river considerably during the time the dams are up. The length between quoins has been fixed at 192 feet. This will admit a boat or raft 160 feet in length.

In the Levisa and Tug forks, having in view the narrowness of the streams and their small low-water discharge, the former making it advisable to save as much space laterally as possible and the latter rendering it imperative that no water be wasted, a different idea will be presented for consideration—that of tandem locks. It is proposed to make these locks about 28 feet in width, with an available length of about 300 feet. Such a lock will accommodate the same number of barges as the locks proposed below Louisa, but these will be placed end to end instead of abreast. In order to save water in passing packet boats or small craft the chamber will be provided with an intermediate gate, so that but one-half the lock need be filled and emptied.

Dams.—Most of the dams, if not all, will be movable. In the Big Sandy there is sufficient width to permit the construction of a central pier between pass and weir if desired. Above Louisa this is not advisable, the rivers being so narrow.

As at present constructed a movable dam usually consists of a pass for navigation occupying about half the width of the stream next the lock and having a sill approximately at the level of the crests of the bars in the vicinity, and one or more weirs with sills considerably higher occupying the other half and terminating in an abutment, the two parts and the weirs, if more than one, separated by piers. The foundations are of masonry. The superstructure is of wood and steel, and may vary considerably in its principles of construction and operation.

The necessity for a deep pass is apparent. At times when there is abundant water it serves to accommodate all navigation without the delay incident to locking. It is probable that when the slack-water system on a stream has been completed so that commerce can move in summer as well as winter, the value of the navigation pass will not be as great as while the system is under construction and incomplete, during which time it will be necessary for it to take advantage quickly of all rises. In order to do this delay at the locks could not be tolerated, and an opening must be provided through which large tows can be taken speedily after the arrival of sufficient water. But even if a deep pass were not required for navigation, if all craft passed through the lock from choice, there is still need for such a sluice in times of flood for facilitating the escape of water and the return of conditions favorable for navigation. As has been said, its sill should approximate the level of neighboring bars; it should be possible to go over it at all times when the bars themselves can be passed. The length or width of this opening should always be sufficient to accommodate navigation at medium stages and in combination with the weir to permit the water to pass without raising a perceptible head at low stages. The weir is as much a necessity as the pass in times of flood, but it is unnecessary to separate the two parts by a pier, which at once becomes a serious obstruction to navigation and a hindrance to the passage of floods upon lowering the dam. In order to more easily maneuver the dam in two or more sections the pier has come to be a regular part of every movable dam, but in narrow streams some other method of maneuvering should be devised.

In addition to the usual pass and weir a drift chute will be a necessity on these rivers. It is not practicable with the present appliances and modes of construction, even on a low-lift dam, for one man to readily maneuver the weir for the purpose of holding the pool at a fixed stage or for the passage of driftwood. Pool level fluctuates too much for the safety and convenience of navigation, and at times of approaching floods the pools are often lowered too rapidly above and raised too rapidly below because of the danger of the dam being caught standing when the flood arrives. It is therefore important, particularly in very high dams, to provide a regulating weir whose closing apparatus shall always be under control and which can be maneuvered with certainty, night or day, by the watchman on duty. The proper location for such chute is as far from the lock as possible, so that the water and drift passing over it may not disturb navigation through the lock. It will therefore be next the abutment, and will not be separated from the weir proper by pier, which at that point might be a menace to navigation. The dimensions of this chute will only be such as will safely pass the drift, usually running previous to the stage at which it is necessary to lower the dam, and serve to regulate the pool at medium stage.

As has been stated, the superstructure or dam proper may vary on different dams, or even on the same works two or more types of movable dam may be employed. The dam at Louisa is of the needle type. On the Ohio and Great Kanawha the wicket of Chanoine with Pasqueau's modified hurter is in use, and experimental sections of bear trap and other forms are being built. Considerable study has been given to the form of dam for the Big Sandy below Louisa, but at this writing it has been only partially developed. The pass will probably be of needles with widely spaced trestles for support. The weir may be of similar character, but its great height on a dam 18 feet high would make its maneuvers difficult, or at least unsatisfactory, and it would be advisable to adopt a system where both lowering and raising can be performed under considerable head. The drift chute may be a drum weir, bear trap, or some simple form of dam or gate, readily removed and replaced, in whole or part, as the conditions may require.

At this time it is not necessary to consider the type of dam for Levisa and Tug rivers. Experience, time, the march of invention, and changes in men's ideas may all have their influence in dictating these, and they may safely be left to the future.

Estimated cost.—Of course any estimate made can be but approximate, because the investigations of probable sites are not thorough. The whole amount of money expended upon the survey would probably not have been sufficient, if expended alone upon the prospecting work, to have completed in a satisfactory manner one-half the locations. With the funds at hand very little could be done along this line, but that little will prove of material use in making the estimates.

The character of work proposed is similar to that contemplated below Louisa, the masonry being wholly concrete, and the quantities are based on those required by those works, increasing or decreasing the same according to the depths to bed rock indicated by the borings. The prices used in arriving at the cost are those received for the two locks in Big Sandy, those for Lock No. 1 being used when the depth to bed rock is less than 12 feet below low water, and those for Lock No. 2 when the depth is 12 feet or more. * * *

V. PROSPECTIVE COMMERCE.

General.—An area of about 4,500 square miles is drained by the tributaries of Big Sandy River. It is rough and mountainous, with narrow valleys containing crooked, rapid creeks, which are swollen beyond their banks in flood time and run entirely dry in seasons of drouth. There are many springs to feed them, but even these nearly all fail after long-continued dry weather. Originally this land was covered with a rich growth of oak, poplar, walnut, and less valuable timbers, but the forest area has been gradually reduced until now, while still forming the chief source of commerce and wealth in the valley, its end is almost in sight. Twenty-five years hence will probably see the annual product of 2,000 to 3,000 rafts now run out reduced to that many hundreds. The land, never exceedingly fertile as a whole, has been cultivated too long and continuously, and its character being largely of sand, has made it an easy prey to the erosive action of rains and running streams, so that at present it is of little value in the production of commerce and wealth. It does well to sustain the life that is upon it. What, then, is to be the source of the commerce to be carried out upon this proposed slack-water improvement? There is but one real hope. The region lies within the great Appalachian coal field. It contains iron ore, clays of various kinds, building stones, salt, oil, and gas, but of none of these is much expected. Almost the entire hope of commercial development is centered in the vast quantities of bituminous coal which underlie almost the whole of this mountainous country and await a means of transportation to market. Once that is at hand it is believed that its development will be speedy and successful.

Quantity of coal.—Professor Brown's report, referred to heretofore, gives the locations, sizes of veins, and analyses of the various coals found in the Big Sandy Valley, and it is only necessary in this report to summarize the approximate quantities.

As an introduction to this summary it may be well to quote from the Brown report the following:

"In order to form some idea of the total possible traffic that the coal of the Big Sandy Valley may furnish to the river when improved and railroads when built, estimates of the total tonnage of coal will be made, but it must be remembered that any statements as to the quantity of coal that may be obtained from any particular large area of this valley must of necessity be rough estimates, on account of the lack of accurate data as to the areas and thickness of the various veins.

"In making the estimates that will be given hereafter, every precaution will be taken to make them conservative and less than the general belief of those persons best able to judge the matter from a thorough acquaintance with the valley. Some of the companies holding large areas of the coal lands have had a few surveys made of the crop lines of the principal veins on their lands, and these have been made use of. The topographical contour maps made by the United States Geological Survey were studied on the ground, and other notes taken from observations made during an extended tour of the valley.

"It will be estimated that 1,000 tons of 2,000 pounds each can be shipped for each foot of thickness from each acre. This is to include the total shipment of coal, including lump, nut, and pea coal. This allows for about 700 tons per foot per acre to be lost in ribs and pillars and in 'faults' and 'horsebacks.' In many mines 1,200 tons of lump coal, besides the nut and pea coal, is shipped from each acre for each foot of thickness of clean coal.

"The above assumptions give 640,000 net tons (2,000 pounds) for each foot of thickness for each square mile, and this number will be used in the estimates made below."

The summary here presented is of the coal tributary to the proposed slack-water improvement, and is made up partly from the above-mentioned report and partly from other sources and is believed to be an exceedingly conservative estimate:

	Tons.
Lawrence County, Ky	150,000,000
Johnson County, Ky	600,000,000
Martin County, Ky	300,000,000
Floyd County, Ky	350,000,000
Pike County, Ky	1,000,000,000
Knott County, Ky	100,000,000
Letcher County, Ky	100,000,000
Wayne County, W. Va	50,000,000
Mingo County, W. Va	350,000,000
Total	3,000,000,000

In order to be able to form some idea as to the significance of the above figures, some statistical information is given as to the area, production, and water shipment of coal in the United States.

The Appalachian coal field furnishes about two-thirds of all the bituminous output of the United States, and is about 900 miles long and contains about 63,000 square miles. Of this area West Virginia has 17,000 and Kentucky 9,000 square miles. Nearly one-half the latter lies tributary to the rivers under consideration—Big Sandy, Levisa, and Tug.

The largest coal-producing area in this field is that of Pennsylvania, which ranges from 40,000,000 to 50,000,000 tons per annum. Of this about 3,000,000 tons are shipped by water to Western and Southern points. The total bituminous coal production of the United States varies from 130,000,000 to 140,000,000 tons per annum. The total lake shipments of bituminous coal amount to from 5,000,000 to 6,000,000 tons per annum.

It will be seen from the above figures that the quantity of coal estimated in the Big Sandy field is equivalent to the entire output of the United States for nearly twenty years, would supply the production of the Pennsylvania field for over fifty years, would furnish that transported from Pittsburg by river for one thousand years, and would equal the entire lake traffic for four hundred and fifty years.

VI. TABLES.

The following tables are presented with this report:

1. Description of bench marks on Big Sandy River
2. Description of bench marks on Levisa Fork.
3. Description of bench marks on Tug Fork.
4. Shoals in Levisa Fork.
5. Shoals in Tug Fork.
6. Discharge measurements, Big Sandy River.
7. Discharge measurements, Levisa Fork.
8. Discharge measurements, Tug Fork.
9. Elevation of low-water surface each mile.
10. Distances to points on Big Sandy River.
11. Distances to points on Levisa Fork.
12. Distances to points on Tug Fork.
13. High and low water stages at Louisa, Ky.
14. High and low water stages at Pikeville, Warfield, and Williamson.
15. Average stages of water at Louisa, Ky.

Bench marks.—In the preparation of the description of the bench marks complete details were not given, as many of them have numerous reference points which are recorded in the survey books by means of diagrams. The idea here is to give sufficient information to fix the locality in which the bench marks will be found and then refer to the diagrams for the data by which their exact locations may be ascertained, should it not be possible to find them upon inspection of the locality. The character of bench mark used is described in the second part of this report.

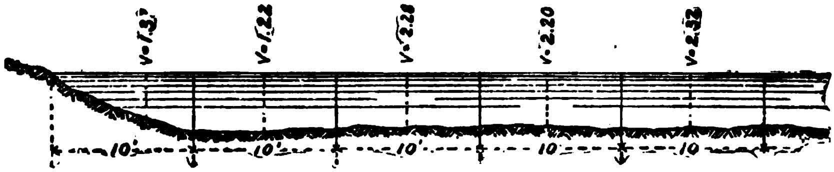
The elevations are above mean sea level as given by the survey of the Ohio River.

Shoals.—There are no shoals on the Big Sandy itself. On Levisa and Tug forks there are several which have not been mentioned in the tables because their fall is slight. Some of them were formerly quite formidable, but the filling up of the river with sand and the annual clearing of rocks from the chutes and head have reduced them until they are scarcely noticeable.

The distances given are from the junction of the rivers at Louisa. The lengths are approximate, it being difficult to determine at what point to begin and end in many of the shoals, while others are broken into several small ripples and pools, covering quite a distance in the aggregate, the rapid portion at the same time being but a small percentage of the whole.

Discharge measurements.—In preparing data for the discharge measurements the following form of notes was used:

Distance to meter.	Time.	Revolution of meter.	Velocity.	Distance to rod.	Depth.	Area.	Discharge.
Feet.	*Seconds.*		*Foot-seconds.*	*Feet.*	*Feet.*	*Square feet.*	*Cubic foot-seconds.*
7	10	5.6	1.37	10	4.0	20.0	27.4
15	10	5.0	1.22	20	3.6	38.0	46.4
25	10	9.3	2.28	30	3.3	34.5	78.6
35	10	9.5	2.20	40	3.2	32.5	71.5
45	10	10.0	2.32	50	3.2	32.0	74.2



CROSS SECTION

It has not been possible during the past season to secure an extreme low-water discharge, and the lowest figures shown in the tables indicate discharges for past low-water stages, as also are the higher stages given those of past years.

Distances.—These tables give the distances in miles to well-known points along the rivers. No attempt has been made to give them to each creek and shoal, but simply a considerable number to the places most generally known. On the Big Sandy the distances are from the Ohio, and on Levisa and Tug forks they are given both from the Ohio and the mouths of the streams themselves.

Water stages.—The tables of high and low water stages give the extremes of each month so far as they have been kept during the past several years. Stations were not established elsewhere than Louisa until after the completion of the dam in 1896.

TABLE 1.—*Description of bench marks, Big Sandy River.*

No.	Elevation.	Station.	Locality.	Description.
	Feet.			
1	543.900	15	Catlettsburg	Foot of Webster street, 55 feet from corner Oakland avenue.
2	552.960	116	England Hill	25 feet west railroad, at line Caldwell and Richardson.
3	550.870	233	Campbells Branch	30 feet east railroad, and 81 feet S. 20¼ W. from trestle.
4	554.166	337+40	Opposite Docks Creek	628 feet east railroad, at line Bryant and Lockwood.
5	543.331	443+90	Lockwood Station	324 feet east store, at road leading to ferry.
6	558.733	563+20	Burgess Station	783 feet east railroad, at road crossing.
7	552.980	676	Lock No. 2	S. 75° 55′ E., 211 feet from hickory.
8	575.993	820	Tom Cartmill's	68 feet west railroad, and 148 feet from cattle guard.
9	555.173	937+20	Burk Branch	43 feet east railroad, and 245 feet from end trestle No. 218.
10	569.587	1,073+50	Catalpa	In line Maynard and Smith, near river bank.
11	586.793	1,169+50	Widow Hulett's	45 feet west railroad, and 20 feet east county road.
12	578.691	1,280+10	Old Licks	219 feet north railroad, at cattle guard.
13	569.570	1,400	Lock No. 3	89.6 feet west office, near road to river.

TABLE 2.—*Description of bench marks on Levisa Fork.*

No.	Elevation.	Station.	Locality.	Description.
	Feet.			
1	574.233	104+16	Jas. C. Johns	On river bank at 2-mile stake.
2	579.151	212+20	Harry Stanbery	75 feet north trestle No. 345, near right-of-way line.
3	580.367	319+66	Torchlight Tipple	150 feet south coal tipple and 30 feet north of switch.
4	587.999	414+21	Devils Nubbin	30 feet west railroad at cattle guard.
5	591.559	525+69	Opposite Wm. Carey's	South railroad, near line T. J. Burgess and James Shannon.
6	586.536	633+81	Opposite Shannon Branch	Line between T. J. Burgess and M. L. Burgess.
7	597.554	741+92	Kise Station	30 feet south line John Burgess and Gord Burgess.
8	589.622	856	Tadpole Branch	West of railroad, on Robert Preston's land.
9	591.506	949+50	Hygeia Station	45 feet west railroad, ¼ mile south station.
10	592.859	1,055+58	Richardson Station	On river bank, ¾ mile south Richardson.
11	595.261	1,160+78	Bumble Bee	On James Preston's land, 700 feet above Joseph Preston's house.
12	598.894	1,266+93	Lost Creek	Opposite James George's.
13	605.354	1,383+05	Jesse Murray's	¼ mile south Jesse Murray's, near railroad.
14	604.475	1,478+99	White House	700 feet northwest depot, at White House.
15	595.106	1,570+14	Wild Goose	10 feet east county road, opposite Widow Gambill's house.
16	609.837	1,722+29	Greasy	On Jos. Fraley's farm, west bank, Greasy Shoal.
17	608.479	1,798+85	Viney Preston	400 feet above Wm. Preston's landing at Viney Preston's shoal.
18	612.349	1,923+99	Buffalo	400 feet below mouth Buffalo Creek; pin in rock.
19	604.327	1,997	Preston Branch	Left bank, 1,600 feet below Jeffey Ripple.
20	621.334	2,112	Hells Gate	¼ mile below Hells Gate Shoal, on right bank.
21	618.977	2,207+72	John Duncan Shoal	Robert Stafford's land above Duncan Shoal.
22	620.637	2,322+51	Opposite Clate Preston	On line John Music and Martin Music, left bank.
23	615.909	2,420+52	Opposite Polk Auxier's	In flat rock ¼ mile below Little Paint Creek.
24	621.769	2,519+88	Johns Creek	Opposite Gobel Branch.
25	630.933	2,652+66	Bayes Ripple	James Wells's land, 1,500 feet above Fraleys Branch.
26	626.081	2,754+68	Moody George	¼ mile above Moody George Shoal.
27	631.717	2,848+84	Abbott.	On rock on James Hatcher's land below Abbott Creek.
28	640.371	2,959+59	Prestonsburg	1,500 feet east court-house, Prestonsburg.
29	639.906	3,097+48	Brandy Keg	99.5 feet S. 16° 20 W., large rock in J. W. Mayo's field.
30	644.874	3,223+83	Sugar Loaf	Line between F. Walker and Jackson Dotson.
31	649.736	3,345+88	Banner Bend	Near coal chute on Martha Leslie's land.
32	646.916	3,438+79	Hawes Ford	By lane near John Finlayson's house.
33	650.455	3,561+53	Cecil Shoal	1,500 feet below R. Hall's landing.
34	655.458	3,664+78	Davidson	In Davidson's orchard, 600 feet from monument.
35	652.875	3,782	Sant Layne's	In Sant Layne's orchard.
36	657.801	3,887+90	Mare Creek	1,500 feet above Mare Creek, line Stratton and Layne.
37	667.924	3,990+25	Layne Branch	Lower end Wm. Layne farm.
38	662.741	4,085+90	Laynesville	At Grimes Shoal, on T. M. Layne's land.
39	665.324	4,200+93	John Lee Hatcher	¼ mile above shoal, lower end Lowe farm.
40	678.638	4,302+51	Cow Pen	By old schoolhouse, 600 feet below Cow Pen Creek.
41	673.845	4,409+21	Stone Coal	300 feet below C. Reynolds's house.
42	672.671	4,510+57	Keel's store	Near garden at Keel's store.
43	682.197	4,626+03	Cecil place	Inside orchard, across road from house.
44	683.852	4,717+23	Pikeville	In court-house yard, near corner.

TABLE 3.—*Description of bench marks on Tug Fork.*

No.	Elevation.	Station.	Locality.	Description.
	Feet.			
1	562.108	20+40	Point	Kentucky, line James Fitspatrick and Geo. Bartram.
2	585.067	183+95	Crit See	West Virginia, by county road on McD. Peck's land.
3	585.193	204+95	Saltpeter	Kentucky, Gid Williamson's yard.
4	548.542	322+50	Vinson Branch	Kentucky, ¼ mile below Vinson Branch.
5	587.822	420+65	Donithan	West Virginia, 100 feet below Lace Hardwick's barn.
6	589.523	534+57	Yorkville	West Virginia, in yard at York's store.

TABLE 3.—*Description of bench marks on Tug Fork*—Continued.

No.	Elevation.	Station.	Locality.	Description.
	Feet.			
7	591.576	609+08	Yellow Creek	West Virginia, mouth of lane, Mose Damron land.
8	603.122	730+71	Opposite Baker Branch	West Virginia, by road and rock fence opposite Baker Branch.
9	602.936	820	Yankee Copley	Kentucky, upper side Copley's orchard.
10	604.701	922+18	John Smith	Kentucky, garden fence near Curry's barn.
11	599.917	1,021+52	Endicott Shoal	West Virginia, line Robert Mead and Isabel Sammons.
12	608.337	1,132	Fluty Lick	West Virginia, in Robert Copley's orchard.
13	603.132	1,227	Bull Creek	West Virginia, at Sam Crum's barn, below Bull Creek.
14	609.636	1,333+24	Big Elk	West Virginia, 200 feet below Eli Crum's house.
15	615.708	1,420	Seven Horns	Kentucky, 100 feet above Nep Harmon's house.
16	614.487	1,531+14	Silver Creek	Kentucky, 200 feet above Tolbert Roman's house.
17	615.288	1,633+91	Stone Coal	West Virginia, 250 feet above Wm. Mead's store.
18	622.194	1,757+42	Lick Shoal	West Virginia, in Harvey Stepp's field.
19	625.375	1,863+25	Warfield	Kentucky, in J. D. Barret's yard.
20	621.141	1,953+05	Wolf Creek	Kentucky, 1,000 feet below Wolf Creek.
21	627.086	2,053+64	Wolf Shoal	Kentucky, 300 feet above John Evans's house.
22	634.281	2,166+14	Long Branch	West Virginia, upper end James Evans's farm.
23	639.559	2,260	Naugatuck	West Virginia, between river and railroad, near sawmill.
24	638.644	2,392+26	Granny Starr	West Virginia, between Oldfield Branch and Davis Branch.
25	640.831	2,508+40	Jo Dempsey	West Virginia, above Dempsey house, between railroad and river.
26	640.799	2,622	Nolan	West Virginia, 250 feet above schoolhouse.
27	646.949	2,760	Alley Island	West Virginia, 30 feet from Norfolk and Western Railroad, ¼ mile above Adrian Hatfield's.
28	651.186	2,910	Sugartree Falls	West Virginia, above Tom Stepp's house, between railroad and river.
29	659.287	3,012+48	Nausimon	West Virginia, on J. B. Slater's farm, on river bank.
30	660.774	3,096	Williamson	West Virginia, in jail yard.

TABLE 4.—*Shoals in Levisa Fork.*

[Measurements from Louisa to head of shoals.]

Name.	Distance.	Length.	Elevation.	Fall.	Fall by survey 1875.
	Miles.	*Feet.*	*Feet.*	*Feet.*	*Feet.*
White House	28.6	700	551.69	1.14	3.38
Wild Goose	29.8	1,500	556.47	1.14	1.10
Greasy	32.8	2,000	560.32	1.63	3.67
Lafe Preston	33.4	300	561.99	1.41	.60
Viney Preston	33.9	400	562.99	.90	.95
Buffalo	36.1	3,500	568.42	5.07	4.2
Hells Gate	40.0	400	571.53	1.06	2.0
Devils Drawbars	40.3	300	572.53	.89	....
John Duncan	41.8	400	573.77	1.28	....
Widow Preston	42.8	400	575.84	2.00	....
Auxier	45.1	300	576.60	.60	....
Hager	48.2	800	581.78	.94	2.66
Wiremans	49.2	700	584.30	2.24	1.99
Bayes Ripple	50.3	500	585.50	1.20	....
Moody George	51.2	600	586.64	.88	1.80
Abbott	53.3	500	589.05	.40	2.07
Prestonsburg	55.0	700	592.75	.93	1.83
Sugar Loaf Shallows	60.4	2,000	597.64	1.82	....
Banner	63.2	209	600.97	.67	....
Ivy	69.4	1,000	609.47	.61	....
Laynes Mill Dam	70.8	500	612.10	.98	....
Stratton	73.4	700	614.16	.74	....
Grimes	76.6	800	620.40	1.99	....
John Lee Hatcher	78.4	400	622.15	1.47	....
Long	85.9	2,800	632.46	3.06	....
Cedar	86.3	200	633.07	.60	....
Pikeville	88.4	1,000	634.51	.71	....

TABLE 5.—*Shoals in Tug Fork.*

[Measurements from Louisa to head of shoals.]

Name.	Distance.	Length.	Elevation.	Fall.	Fall by survey 1875.	Fall by survey 1884.
	Miles.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Falls	10.5	300	533.94	0.41	3.50	0.40
Copley	13.3	300	541.73	.33	2.86	2.05
Drag	15.0	500	544.15	.36	....	.57
Twisting	15.3	600	545.71	1.21	2.10	2.49
John Smith	16.7	300	547.00	.34	1.17	1.15
Twin or Endicott	18.7	1,200	549.44	.44	....	1.52
Whitt Bend	20.4	1,200	552.77	1.72	....	1.55
Calf Creek	21.5	500	553.92	.55	....	.83
Bull	22.7	700	555.12	.30	....	1.78
Turkey	23.4	600	556.44	.58	....	2.20
Fish Trap	25.3	150	558.81	.42	....	.20
Crum Mill Dam	27.1	700	564.21	3.06	....	4.31
Lick	33.0	400	571.91	2.33	4.57	3.52
Marrow Bone	33.9	200	573.15	.98	.95	.71
Buck Creek	34.4	500	574.82	1.38	1.50	2.44
Wolf	37.9	2,900	582.29	4.22	....	7.41
Sand Gut	38.8	300	583.70	1.35	....	.75
Yosie Sluice	39.4	500	586.05	.85	....	2.02
Parsley or Big Branch	39.6	300	587.30	1.22	....	1.85
Long Branch	40.0	900	589.54	1.42	....	1.87
Carter	40.7	150	590.30	.52	....	.61
Pigeon	41.3	600	593.88	3.41	....	3.56
Levi Starr	43.2	400	595.82	1.25	....	1.00
Granny Starr	44.3	300	596.80	1.31	....	1.75
Mt. Sterling	45.0	400	598.22	1.38	....	1.28
Jo Dempsey	46.4	600	600.81	1.95	....	1.58
Coleman	48.0	300	603.06	1.28	....	1.62
Tank	49.8	200	604.85	.66	....	....
Jimmy Taylor	50.1	1,000	607.50	2.65	....	2.57
Alley Island	51.6	400	609.19	.69	....	1.11
Alley Mill Dam	51.7	600	610.68	1.49	....	1.88
Buffalo	52.7	400	612.95	2.05	....	.98
Sugar Tree Falls	53.9	300	615.36	1.37	....	1.46
Upper Turkey	55.3	600	617.58	1.36	....	....
Nausimon	55.9	150	619.60	2.06	....	2.16

TABLE 6.—*Discharges in Big Sandy River below Dam No. 3, Louisa, Ky.*

Date.	Stage above low water.			Mean velocity per second.	Discharge per second.	Remarks.
	Rising.	Falling.	Standing.			
				Feet.	*Cubic feet.*	
Oct. 22, 1897	....	....	0.0	....	48	After completion of dam.
Oct. 23, 1900	....	....	1.3	1.47	251	
June 10, 1886	....	1.9	....	1.80	1,242	
1891	....	....	2.3	....	1,794	Exact date unknown.
July 24, 1891	3.3	....	....	2.11	2,425	
1891	3.8	....	....	2.72	3,319	Do.
1891	4.3	....	....	2.99	4,910	Do.
July 25, 1891	4.4	....	....	2.76	4,029	
July 28, 1891	5.1	....	....	2.88	4,817	
1891	5.3	....	....	3.21	6,362	Do.
1891	6.3	....	....	3.42	7,750	Do.
July 26, 1891	....	6.5	....	3.14	6,463	
Apr. 13, 1886	....	....	6.9	1.00	2,000	Backwater from Ohio near.
Aug. 24, 1891	7.2	....	....	3.89	8,980	
1881	7.3	....	....	3.56	9,088	Exact date unknown.
1891	8.3	....	....	3.72	10,525	Do.
Aug. 24, 1891	8.9	....	....	4.00	11,140	
1891	9.3	....	....	4.06	12,585	Do.
Aug. 24, 1891	9.6	....	....	4.50	13,487	
1891	10.3	....	....	4.21	14,238	Do.
Feb. 17, 1886	....	11.0	....	4.10	14,990	
1891	11.3	....	....	4.30	15,988	Do.
Aug. 26, 1891	....	12.1	....	3.83	14,269	
1891	12.3	....	....	4.64	18,900	Do.
1891	13.3	....	....	4.71	20,850	Do.
Aug. 25, 1891	13.8	....	....	4.78	19,678	
Aug. 25, 1591	14.5	....	....	4.70	21,505	
Mar. 31, 1886	23.3	....	....	6.30	45,250	

TABLE 7.—*Discharges in Levisa Fork.*

Date.	Location.	Stage above low water.		Discharge per second.
		Rising.	Falling.	
				Cubic feet.
Nov. 8, 1899	Above Gallup	....	0.2	56
Oct. 22, 1900	.....do	....	0.5	120
Sept. 22, 1900	.....do	0.7	....	358
Do	White House	0.7	....	282
Sept. 23, 1900	Paintsville	0.7	....	280
Sept. 24, 1900	Prestonsburg	1.3	....	249
Do	Mud Creek	....	2.0	947
Sept. 25, 1900	Pikeville	....	1.4	848

TABLE 8.—*Discharges in Tug Fork.*

Date.	Location.	Stage above low water.		Discharge per second.
		Rising.	Falling.	
				Cubic feet.
Nov. 7, 1899	Dan Vinson's	....	0.3	68
Oct. 23, 1900	.....do	0.5	....	78
Oct. 4, 1900	Falls	....	1.0	171
Oct. 3, 1900	Warfield	....	1.1	198
Oct. 2, 1900	Williamson	....	1.2	192

TABLE 9.—*Elevation of low-water surface at 1-mile intervals.*

[Distances measured from the Ohio River.]

Big Sandy.				Levisa Fork.				Tug Fork.			
Distance.	Elevation.	Rise.	Total rise.	Distance above Louisa.	Elevation.	Rise.	Total rise.	Distance above Louisa.	Elevation.	Rise.	Total rise.
0	488.91	....	....	....	....	....	....	....	....	....	....
1	495.00	6.09	6.09	....	....	....	....	....	....	....	....
2	499.10	4.10	10.19	....	....	....	....	....	....	....	....
3	499.38	.28	10.47	....	....	....	....	....	....	....	....
4	499.65	.27	10.74	....	....	....	....	....	....	....	....
5	500.90	1.25	11.99	....	....	....	....	....	....	....	....
6	502.80	1.90	13.89	....	....	....	....	....	....	....	....
7	503.50	.70	14.59	....	....	....	....	....	....	....	....
8	504.62	1.12	15.71	....	....	....	....	....	....	....	....
9	505.46	.84	16.55	....	....	....	....	....	....	....	....
10	505.92	.46	17.01	....	....	....	....	....	....	....	....
11	506.22	.30	17.31	....	....	....	....	....	....	....	....
12	506.55	.33	17.64	....	....	....	....	....	....	....	....
13	506.83	.28	17.92	....	....	....	....	....	....	....	....
14	508.55	1.72	19.64	....	....	....	....	....	....	....	....
15	508.74	.19	19.83	....	....	....	....	....	....	....	....
16	510.24	1.50	21.33	....	....	....	....	....	....	....	....
17	511.20	.96	22.29	....	....	....	....	....	....	....	....
18	512.55	1.35	23.64	....	....	....	....	....	....	....	....
19	512.60	.05	23.69	....	....	....	....	....	....	....	....
20	512.75	.15	23.84	....	....	....	....	....	....	....	....
21	513.34	.59	24.43	....	....	....	....	....	....	....	....
22	513.60	.26	24.69	....	....	....	....	....	....	....	....
23	514.30	.70	25.39	....	....	....	....	....	....	....	....
24	515.00	.70	26.09	....	....	....	....	....	....	....	....
25	517.10	2.10	28.19	....	....	....	....	....	....	....	....
26	518.00	.90	29.09	....	....	....	....	....	....	....	....
27	[1] 530.71	12.71	41.80	0	530.71	0.00	41.80	0	530.71	0.00	41.80
28	....	....	....	1	530.71	.00	41.80	1	530.71	.00	41.80
29	....	....	....	2	530.71	.00	41.80	2	530.71	.00	41.80
30	....	....	....	3	530.71	.00	41.80	3	530.71	.00	41.80
31	....	....	....	4	530.71	.09	41.80	4	530.71	.00	41.80

[1] Pool above dam No. 3.

TABLE 9.—*Elevation of low-water surface at 1-mile intervals*—Continued.

[Distances measured from the Ohio River.]

Big Sandy.				Levisa Fork.				Tug Fork.			
Distance.	Elevation.	Rise.	Total rise.	Distance above Louisa.	Elevation.	Rise.	Total rise.	Distance above Louisa.	Elevation.	Rise.	Total rise.
32	....	....	....	5	530.71	.00	41.80	5	530.71	.00	41.80
33	....	....	....	6	530.71	.00	41.80	6	531.07	.36	42.16
34	....	....	....	7	530.71	.00	41.80	7	532.40	1.33	43.49
35	....	....	....	8	530.71	.00	41.80	8	534.04	1.64	45.13
36	....	....	....	9	530.71	.00	41.80	9	536.15	2.11	47.24
37	....	....	....	10	531.60	.89	42.69	10	538.04	1.89	49.13
38	....	....	....	11	532.10	.50	43.19	11	539.07	1.03	50.16
39	....	....	....	12	534.55	2.45	45.64	12	539.15	.08	50.24
40	....	....	....	13	535.79	1.24	46.88	13	540.82	1.67	51.91
41	....	....	....	14	537.18	1.39	48.27	14	542.53	1.71	53.62
42	....	....	....	15	538.70	1.52	49.79	15	544.24	1.71	55.33
43	....	....	....	16	539.46	.76	50.55	16	545.76	1.52	56.85
44	....	....	....	17	539.78	.32	50.87	17	547.13	1.37	58.22
45	....	....	....	18	540.00	.22	51.09	18	547.93	.80	59.02
46	....	....	....	19	541.79	1.79	52.88	19	549.50	1.57	60.59
47	....	....	....	20	543.20	1.41	54.29	20	551.03	1.53	62.12
48	....	....	....	21	544.70	1.50	55.79	21	552.71	1.68	63.80
49	....	....	....	22	545.00	.30	56.09	22	554.37	1.66	65.46
50	....	....	....	23	545.23	.23	56.32	23	555.57	1.20	66.66
51	....	....	....	24	546.44	1.21	57.53	24	556.85	1.28	67.94
52	....	....	....	25	547.62	1.18	58.71	25	557.80	.95	68.89
53	....	....	....	26	548.55	.93	59.64	26	560.05	2.25	71.14
54	....	....	....	27	550.37	1.82	61.46	27	561.76	1.71	72.85
55	....	....	....	28	552.90	2.53	63.99	28	564.27	2.51	75.36
56	....	....	....	29	554.86	1.96	65.95	29	565.00	.73	76.09
57	....	....	....	30	556.53	1.67	67.62	30	565.76	.76	76.85
58	....	....	....	31	557.52	.99	68.61	31	567.56	1.80	78.65
59	....	....	....	32	558.58	1.06	69.67	32	568.55	.99	79.64
60	....	....	....	33	560.40	1.82	71.49	33	571.94	3.39	83.03
61	....	....	....	34	563.00	2.60	74.09	34	573.18	1.24	84.27
62	....	....	....	35	563.36	.36	74.45	35	574.90	1.72	85.99
63	....	....	....	36	568.26	4.90	79.35	36	575.80	.90	86.89
64	....	....	....	37	568.51	.25	79.60	37	577.80	2.00	88.89
65	....	....	....	38	568.85	.34	79.94	38	582.33	4.53	93.42
66	....	....	....	39	569.54	.69	80.63	39	583.75	1.42	94.84
67	....	....	....	40	571.53	1.99	83.62	40	589.54	5.79	100.63
68	....	....	....	41	572.49	.96	83.58	41	590.47	.93	101.56
69	....	....	....	42	573.71	1.22	84.80	42	594.07	3.60	105.16
70	....	....	....	43	575.84	2.13	86.93	43	594.07	.00	105.16
71	....	....	....	44	575.84	.00	86.93	44	595.47	1.40	106.56
72	....	....	....	45	576.60	.76	87.69	45	598.64	3.17	109.73
73	....	....	....	46	577.45	.85	88.54	46	598.85	.21	109.94
74	....	....	....	47	579.65	2.20	90.74	47	601.24	2.39	112.33
75	....	....	....	48	581.10	1.45	92.19	48	603.17	1.93	114.26
76	....	....	....	49	582.06	.96	93.15	49	603.52	.35	114.61
77	....	....	....	50	584.30	2.24	95.39	50	604.85	1.33	115.94
78	....	....	....	51	585.76	1.46	96.85	51	608.08	3.23	119.17
79	....	....	....	52	586.64	.88	97.73	52	610.37	2.29	121.46
80	....	....	....	53	588.33	1.69	99.42	53	613.03	2.66	124.12
81	....	....	....	54	590.38	2.05	101.47	54	615.36	2.33	126.45
82	....	....	....	55	592.25	1.87	103.34	55	616.16	.80	127.25
83	....	....	....	56	593.03	.78	104.12	56	619.76	3.60	130.85
84	....	....	....	57	593.37	.34	104.46	57	620.56	.80	131.65
85	....	....	....	58	593.59	.22	104.68	58	622.00	1.44	133.09
86	....	....	....	59	594.63	1.04	105.72	......	....	......	....
87	....	....	....	60	596.50	1.87	107.59	......	....	......	....
88	....	....	....	61	597.82	1.32	108.91	......	....	......	....
89	....	....	....	62	599.00	1.18	110.09	......	....	......	....
90	....	....	....	63	600.08	1.08	111.17	......	....	......	....
91	....	....	....	64	601.23	1.15	112.32	......	....	......	....
92	....	....	....	65	602.60	1.37	113.69	......	....	......	....
93	....	....	....	66	604.27	1.67	115.36	......	....	......	....
94	....	....	....	67	606.25	1.98	117.34	......	....	......	....
95	....	....	....	68	607.48	1.23	118.57	......	....	......	....
96	....	....	....	69	608.00	.52	119.09	......	....	......	....
97	....	....	....	70	610.20	2.20	121.29	......	....	......	....
98	....	....	....	71	612.28	2.08	123.37	......	....	......	....
99	....	....	....	72	612.38	.10	123.47	......	....	......	....
100	....	....	....	73	613.17	.79	124.26	......	....	......	....
101	....	....	....	74	614.82	1.65	125.91	......	....	......	....
102	....	....	....	75	615.92	1.10	127.01	......	....	......	....

TABLE 9.—*Elevation of low-water surface at 1-mile intervals*—Continued.

[Distances measured from the Ohio River.]

Big Sandy.				Levisa Fork.				Tug Fork.			
Distance.	Elevation.	Rise.	Total rise	Distance above Louisa.	Elevation.	Rise.	Total rise.	Distance above Louisa.	Elevation	Rise.	Total rise.
103	....	....	....	76	617.30	3.32	128.39	....	....	....	....
104	....	....	....	77	620.62	3.32	131.71	....	....	....	....
105	....	....	....	78	620.68	.06	131.77	....	....	....	....
106	....	....	....	79	622.15	1.47	133.24	....	....	....	....
107	....	....	....	80	623.66	1.51	134.75	....	....	....	....
108	....	....	....	81	624.73	1.07	135.82	....	....	....	....
109	....	....	....	82	626.02	1.29	137.11	....	....	....	....
110	....	....	....	83	627.17	1.15	138.26	....	....	....	....
111	....	....	....	84	628.04	.87	139.13	....	....	....	....
112	....	....	....	85	628.76	.72	139.85	....	....	....	....
113	....	....	....	86	632.46	3.70	143.55	....	....	....	....
114	....	....	....	87	633.10	.64	144.19	....	....	....	....
115	....	....	....	88	633.79	.69	144.88	....	....	....	....
115½	....	....	....	88½	635.50	1.71	146.59	....	....	....	....

TABLE 10.—*Distances from the Ohio River at Catlettsburg, Ky., to points on Big Sandy River, measured along center line of stream.*

Name of place.	Distance.	Name of place.	Distance.
	Miles.		*Miles.*
Lock No. 1	0.8	Turmans Ferry	14.0
Cheasapeake and Ohio Railroad bridge.	1.0	Buchanan	14.7
England Hill	2.0	Dean Bend	16.8
Campbells Branch	4.5	Hubbardstown	18.5
Savage Branch	5.4	Blaine	19.9
Nigger Head	7.3	Fullers	22.0
West Virginia, Whites Creek	8.4	Old Licks	24.8
Durbin Creek	10.1	Lock No. 3	26.5
Cragston Creek	11.4	Louisa	27.0
Lock No. 2	13.0		

TABLE 11.—*Distances from Ohio River at Catlettsburg, Ky., and from the mouth at Louisa, Ky., to points on Levisa Fork, measured along center line of stream.*

Name of place.	Distances from—	
	Louisa.	Catlettsburg.
	Miles.	*Miles.*
Louisa	0.0	27.0
Three-mile Bridge	2.7	29.7
Torchlight Tipple	6.0	33.0
Griffiths Creek	8.9	35.9
Shannon Branch	12.1	39.1
Georges Creek	15.0	42.0
Old Peach Orchard	17.6	44.6
Richardson	19.2	46.2
Graves Shoal	20.8	47.8
Lost Creek	23.5	50.5
Chestnut	24.8	51.8
White House	27.5	54.5
Toms Creek	31.2	58.2
Buffalo Creek	36.3	63.3
Paintsville	38.6	65.6
Hells Gate	40.0	67.0
Widow Preston Shoal	42.8	69.8
East Point	45.6	72.6
Johns Creek	46.3	73.3
Wiremans	49.2	76.2

TABLE 11.—*Distances from Ohio River at Catlettsburg, Ky., etc.*—Continued.

Name of place.	Distances from—	
	Louisa.	Catlettsburg.
	Miles.	*Miles.*
Moody George	51.0	78.0
Patrick Swirl	52.1	79.1
Abbott	53.3	80.3
Prestonsburg	54.9	81.9
Brandy Keg	58.1	85.1
Sugar Loaf	59.5	86.5
Cow Creek	61.9	88.9
Beaver	65.0	92.0
Prater	67.5	94.5
Ivy	69.6	96.6
Mare Creek	72.5	99.5
Mud	75.5	102.5
Cow Pen	79.8	106.8
Stone Coal	83.0	110.0
Pikeville	88.5	115.5

TABLE 12.—*Distances from Ohio River at Catlettsburg, Ky., and the mouth at Louisa, Ky., to points on Tug Fork, measured along center line of stream.*

Name of place.	Distances from—	
	Louisa.	Catlettsburg.
	Miles.	*Miles.*
Louisa	0.0	27.0
Saltpetre	3.7	30.7
Donithan	7.4	34.4
Lost Creek	9.9	26.9
Falls	10.4	37.4
Drag	15.0	42.0
John Smith Shoal	16.7	43.7
Camp Creek	18.0	45.0
Calf Creek	21.8	48.8
Turkey	24.0	51.0
Big Elk	25.5	52.5
Crum Milldam	27.0	54.0
Stone Coal	30.6	57.6
Marrowbone	33.7	60.7
Warfield	34.6	61.6
Wolf Creek	36.5	63.5
Long Branch	40.0	67.0
Pigeon, or Naugatuck	41.9	68.9
Mount Sterling	45.1	72.1
Nolan	48.7	75.7
Alley Island	51.4	78.4
Buffalo	52.7	79.7
Sugar Tree Falls	53.9	80.9
Williamson	57.8	84.8
Pond Creek	58.1	85.1

Table 13.—*High and low water stages, at Louisa, Ky.*

Months.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.
January	....	20.0	28.0	15.8	18.8	9.4	15.8	28.0	26.8
	....	8.0	8.0	8.8	4.2	2.0	4.7	5.8	7.1
February	....	45.8	12.6	21.6	41.2	18.8	21.6	46.2	84.5
	....	8.0	4.5	5.0	9.6	8.0	4.0	6.6	11.9
March	....	85.0	10.6	84.9	22.8	17.2	12.2	40.0	28.5
	....	8.6	8.4	8.7	8.4	4.0	4.5	8.6	7.2
April	....	25.0	26.0	40.8	27.8	10.0	18.9	20.4	20.0
	....	5.0	4.0	4.0	3.8	8.2	8.9	6.4	5.5
May	....	10.6	15.8	29.6	16.9	7.4	12.8	26.3	9.9
	....	8.4	8.8	8.8	2.8	2.4	4.1	6.6	2.8
June	....	8.8	10.9	14.2	9.5	10.9	19.5	6.3	18.6
	....	2.8	2.5	8.8	2.4	1.7	5.4	2.9	4.0
July	....	5.8	2.6	20.6	8.0	....	12.5	9.2	9.3
	....	1.7	1.6	1.2	1.5	....	4.0	2.5	2.7
August	1.9	7.6	9.8	9.0	2.9	....	9.5	9.5	15.0
	0.9	1.6	2.0	2.0	1.4	....	2.7	2.9	2.9
September	1.2	1.6	2.0	2.9	1.4	....	7.4	5.7	5.1
	0.9	0.9	1.2	1.7	0.7	....	2.0	2.7	2.1
October	4.2	2.1	18.8	1.8	1.4	....	4.9	12.5	2.8
	1.2	0.7	1.8	1.0	1.0	....	2.8	2.4	2.0
November	7.6	2.8	10.8	10.5	1.8	....	15.0	8.2	6.4
	1.4	0.8	8.8	1.2	1.0	....	4.4	8.2	1.9
December	26.0	8.7	17.6	18.2	2.9	....	10.6	22.0	10.0
	1.9	1.4	8.8	8.8	1.4	....	4.6	8.0	8.0

Months.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.
January	26.1	18.2	7.9	27.0	6.8	6.9	15.6	80.0	10.0
	5.6	4.6	4.8	5.8	8.2	8.8	8.8	5.7	4.0
February	18.2	48.0	29.1	11.2	16.0	46.6	7.0	82.0	16.5
	4.5	5.5	6.0	4.0	4.8	5.8	4.6	6.5	4.2
March	28.4	11.7	14.8	18.6	88.4	82.2	28.0	48.0	26.0
	4.1	4.8	5.1	6.9	4.8	6.2	4.0	9.5	6.1
April	40.6	22.8	18.6	10.0	86.0	25.5	25.0	20.5	7.4
	6.6	4.7	5.0	5.2	4.8	4.2	6.0	5.5	4.5
May	12.7	84.2	11.8	18.8	5.0	20.1	17.0	16.4	12.8
	5.6	5.0	4.0	5.5	8.0	4.4	5.8	4.2	4.8
June	11.9	14.8	4.8	5.5	18.0	15.0	16.0	18.5	18.4
	3.7	8.6	2.7	2.8	2.9	1.6	2.0	4.1	8.2
July	11.0	6.4	4.4	22.5	19.8	18.0	9.8	4.9	8.8
	8.0	8.0	2.6	8.0	5.1	8.0	3.0	2.5	2.5
August	4.8	6.5	5.1	10.5	17.2	8.6	88.0	6.0	7.0
	2.4	1.9	2.2	2.9	8.8	2.6	5.0	8.0	8.0
September	2.8	5.2	8.4	5.9	5.1	3.0	6.0	2.8	5.5
	1.8	1.6	1.5	2.1	8.2	2.5	8.0	2.5	8.0
October	1.8	12.8	1.5	2.0	6.9	4.0	7.6	2.5	4.6
	1.6	2.6	1.2	1.6	8.8	2.0	8.0	2.8	2.7
November	5.0	10.6	8.0	8.6	18.5	2.0	8.7	8.4	81.5
	1.6	8.8	1.2	1.9	8.4	2.0	8.0	2.8	3.0
December	8.0	18.5	6.1	6.5	16.4	4.6	9.4	6.0	17.4
	3.1	4.2	8.0	2.9	4.0	2.0	5.5	2.8	4.0

TABLE 14.—*High and low water stages at Pikeville, Warfield, and Williamson.*

Months.	Pikeville.			Warfield.			Williamson.			
	1897.	1898.	1899.	1898.	1899.	1900.	1897.	1898.	1899.	1900.
January	....	....	....	....	10.0	4.2	....	....	15.0	4.0
	....	....	....	....	2.9	1.0	....	....	1.6	1.0
February	....	....	....	....	19.6	8.2	....	....	15.0	7.0
	....	....	....	....	2.7	0.8	....	....	1.6	1.0
March	....	....	....	....	19.4	17.6	....	....	15.0	14.0
	....	....	....	....	3.9	1.8	....	....	2.0	1.6
April	....	....	5.0	....	8.2	3.6	....	....	5.0	2.6
	....	....	1.8	....	2.0	1.9	....	....	1.0	1.2
May	....	15.0	9.0	....	8.4	9.4	....	12.0	8.0	6.0
	....	1.0	0.8	....	1.3	1.8	....	1.6	0.8	1.0
June	11.0	9.0	8.0	8.6	4.8	7.2	5.0	8.0	3.6	6.4
	1.6	0.0	0.8	0.8	1.2	0.9	0.0	0.0	0.6	0.8
July	3.0	7.0	....	4.0	1.6	3.7	4.0	5.0	0.4	2.0
	0.8	0.0	....	1.0	0.5	0.3	0.0	0.0	0.0	0.7
August	2.0	18.0	....	30.0	1.7	3.4	1.0	25.0	0.6	3.6
	0.8	0.0	....	0.8	0.4	0.3	0.0	0.0	0.0	0.2
September	1.0	0.0	....	1.8	0.7	2.8	0.0	0.6	0.0	2.0
	0.8	0.0	....	0.3	0.2	0.3	0.0	0.0	0.0	0.0
October	0.8	4.0	....	3.4	1.2	1.8	0.0	4.0	0.0	1.2
	0.6	0.0	....	0.3	0.1	0.5	0.0	0.0	0.0	0.7
November	0.8	2.0	....	3.6	0.7	....	0.0	1.0	1.0	....
	0.6	0.0	....	0.8	0.2	....	0.0	0.0	0.4	....
December	1.6	2.0	....	4.0	2.8	....	2.6	3.0	8.0	....
	0.6	0.0	....	1.3	0.3	....	0.0	0.0	0.6	....

TABLE 15.—*Average stages of water at Louisa, Ky.*

Months.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.
January	....	8.0	6.4	9.1	7.6	4.7	9.1	9.7	12.4
February	....	24.3	6.0	9.8	18.5	5.5	8.0	17.9	20.9
March	....	19.5	5.6	9.8	9.9	6.5	8.1	19.7	14.9
April	....	10.4	9.0	17.0	10.9	4.9	6.9	11.6	11.0
May	....	5.6	5.5	8.1	6.1	3.6	6.6	11.6	3.8
June	....	3.4	4.2	8.3	4.1	3.3	10.5	4.5	8.5
July	....	2.6	2.0	6.8	2.0	....	6.6	4.6	4.7
August	1.2	2.5	3.5	4.5	1.7	....	5.1	4.7	5.7
September	0.9	1.2	1.5	1.9	0.9	....	3.3	3.6	2.7
October	1.9	0.9	2.6	1.8	1.1	....	3.6	4.8	2.2
November	3.7	1.2	5.9	3.1	1.4	....	9.1	4.4	3.0
December	5.5	2.6	6.2	7.8	2.1	....	5.6	5.1	5.1
Average	[1]2.6	6.8	4.9	7.2	5.5	[2]4.7	6.9	8.5	7.9

Months.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.
January	10.0	8.5	6.6	11.9	4.7	5.0	7.3	12.8	5.7
February	6.6	15.8	10.8	5.9	8.9	17.7	5.3	15.9	8.9
March	11.1	7.7	7.9	11.9	11.1	14.5	10.6	19.2	10.5
April	13.9	9.9	7.1	7.3	9.7	9.7	9.3	9.8	5.7
May	8.7	12.8	5.9	8.5	3.7	8.8	8.7	7.9	5.9
June	6.7	6.6	3.5	3.9	5.4	6.0	5.6	5.7	5.7
July	5.1	3.8	3.3	5.7	8.5	5.3	6.5	3.8	4.3
August	3.2	3.2	2.9	5.2	8.0	2.9	11.1	3.9	4.5
September	2.2	2.6	2.0	3.3	4.0	2.7	4.0	2.6	3.9
October	1.7	6.1	1.4	1.8	4.6	2.5	5.2	2.4	3.4
November	3.2	5.3	2.3	2.8	6.1	2.0	5.4	2.9	7.5
December	4.9	5.6	3.8	3.9	7.5	3.2	6.4	3.8	6.8
Average	6.4	7.3	4.8	6.0	6.9	6.7	7.1	7.5	6.1

[1] Five months.

[2] Six months.

CONCLUSION.

In closing this report I desire to say that this survey has emphasized certain facts already pretty well known and made certain some things which were more or less in doubt. The facts established may be enumerated as follows:

(1) The rivers surveyed are not capable of satisfactory improvement by means of works of regulation and contraction because of the scarcity of water during the dry season.

(2) They are capable ot improvement by means of locks and dams, particularly movable dams.

(3) The character and quantity of coal adjacent to these streams, when developed, will amply justify the construction and maintenance of a slack-water system.

(4) The estimates heretofore submitted will cover the cost of the improvements contemplated under this report.

Respectfully submitted.

B. F. Thomas,
Resident Engineer.

Capt. H. F. Hodges,
Corps of Engineers, U. S. A.

APPENDIX J J.

IMPROVEMENT OF FALLS OF OHIO RIVER, OF WHITE RIVER, INDIANA, AND WABASH RIVER, INDIANA AND ILLINOIS, AND OF CERTAIN RIVERS IN KENTUCKY.

REPORT OF CAPT. WM. L. SIBERT, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1901, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Falls of the Ohio River at Louisville, Kentucky.
2. Operating and care of Louisville and Portland Canal, Kentucky.
3. Wabash River, Indiana and Illinois.
4. Operating and care of lock and dam at Grand Rapids, Wabash River.
5. White River, Indiana.
6. Lock No. 2, Green River, at Rumsey, Kentucky.
7. Green River, above mouth of Big Barren River, Kentucky.
8. Operating and care of locks and dams on Green and Barren rivers, Kentucky.
9. Rough River, Kentucky.
10. Operating and care of lock and dam on Rough River, Kentucky.
11. Removing sunken vessels or craft obstructing or endangering navigation.

EXAMINATION.

12. Ohio River at Sand Island, Kentucky.

UNITED STATES ENGINEER OFFICE,
Louisville, Ky., July 18, 1901.

GENERAL: I have the honor to transmit herewith annual reports for the works under my charge at the close of the fiscal year ending June 30, 1901. * * * This district was in charge of Capt. George A. Zinn, Corps of Engineers, to July 6, 1900.

* * * * * * *

Very respectfully, your obedient servant,

WM. L. SIBERT,
Captain, Corps of Engineers.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

J J 1.

IMPROVEMENT OF FALLS OF OHIO RIVER AT LOUISVILLE, KENTUCKY.

The original condition, objects of the improvements, projects, and present work are fully described in annual reports of the Chief of

Engineers as follows: 1882, page 1881; 1883, page 1539; 1890, page 2217; 1899, pages 2553–2564.

During the fiscal year 1901 operations at the head of the Louisville and Portland Canal were directed toward drilling, blasting, and the removal of disrupted rock within the limits of the project; to the construction of a new hull for one of the dredges used on this work and transfer of machinery from the old to the new hull, and to securing and making ready steel guide buoys for marking the northerly line of excavation.

Work on the Indiana Chute side of the river consisted of the completion to prescribed grade of excavation in the channel above the railroad bridge, completion of excavation at Willow Point, repairs to Willow Point dike, completion of excavation at Wave Rock, and completion of part of Wave Rock dike.

The details and quantities of the work accomplished, as well as that remaining to be done under the project, are set forth in the accompanying reports of Messrs. J. H. Casey and Granville W. Shaw, assistant engineers.

Money statement.

July 1, 1900, balance unexpended	$139,817.25
June 30, 1901, amount expended during fiscal year	105,201.88
July 1, 1901, balance unexpended	34,615.88
July 1, 1901, outstanding liabilities	873.93
July 1, 1901, balance available	33,741.44
Amount (estimated) required for completion of existing project	132,389.79
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	132,389.79
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS FOR IMPROVING FALLS OF OHIO RIVER AT LOUISVILLE, KY.

Enlargement at head of canal and of basin at locks:		
July 5, 1884	$300,000	
August 5, 1886	150,000	
August 11, 1888	150,000	
September 19, 1890	60,000	
July 13, 1892	60,000	
August 18, 1894	60,000	
		$780,000
Appropriations for improving falls of Ohio River and Indiana Chute Falls, Ohio River:		
June 3, 1896	10,000	
June 4, 1897	350,000	
July 1, 1898	152,250	
March 3, 1899	15,000	
		527,250
Allotments for Indiana Chute from appropriations for improving Ohio River:		
July 14, 1880	10,000	
March 3, 1881	50,000	
August 2, 1882	35,000	
July 5, 1884	10,000	
August 5, 1886	20,000	
August 11, 1888	15,000	
		140,000

Appropriations for work on Indiana Chute:		
September 19, 1890	$25,000	
July 13, 1892	35,000	
August 18, 1894	20,000	
		$80,000
Total		1,527,250

No contracts for this work were in force during the fiscal year.

Commercial statistics are given in the report for operating and care of the Louisville and Portland Canal.

REPORT OF MR. J. H. CASEY, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
IMPROVING FALLS OF OHIO RIVER AT LOUISVILLE, KY.,
Louisville, Ky., June 30, 1901.

CAPTAIN: I have the honor to submit the following report of operations connected with the enlargement of the head of the Louisville and Portland Canal, under approved project March 31, 1899, for improving Falls of Ohio River at Louisville, Ky., for the fiscal year ending June 30, 1901.

The principal work accomplished during the year was drilling and blasting, and dredging rock ledge east of cross dam, under cross dam and strip west, and under guiding dike.

Building new hull for and making repairs to dredge *Wabash*.

Five steel-spar guide buoys were purchased to be placed at the head of canal to mark the channel line of basin or south line of rock excavation.

EARTH EXCAVATION.

As reported in annual report for fiscal year ending June 30, 1900, there were 21,629 cubic yards of sediment to be removed in old section 3, Gleason & Gosnell. The dredges *Louisville No. 1*, *Wabash*, and *Green River No. 1* were engaged from time to time during January, February, and March removing the above deposit, and a part of it has been scoured off by the rises in the river. While dredging disrupted rock under guiding dike it was necessary in order to get all the rock to dredge a considerable quantity of the above mud and loose rock deposit.

Quantity of mud and loose rock deposit dredged, 11,809 cubic yards.

EARTH EXCAVATION, SOUTH SIDE OF CANAL.

No work has been done under this head.

	Cubic yards.
Quantity to be removed July 1, 1900	14,583.2
Quantity added to above on account of revised estimate submitted November 10, 1900	4,278.7
Quantity to be removed July 1, 1901	18,861.9

ROCK EXCAVATION, SOUTH SIDE OF CANAL.

On June 25, 1900, a survey between Fourteenth Street Railway Bridge and east end of old guard gate was commenced for the purpose of making a revised estimate of the work on the south side of the canal. This survey was completed in August of the same year.

Quantity of solid rock to be drilled, blasted, and removed July 1, 1900 ... cubic yards..	3,740.0
Quantity added on account of revised estimate submitted November 10, 1900 ... cubic yards..	1,253.1
Total	4,993.1
Quantity drilled, blasted, and removed from July 1, 1900, to June 30, 1901 ... cubic yards..	0.0
Quantity to be drilled, blasted, and removed July 1, 1901 ... do....	4,993.1

WALL AND SLOPE REVETMENT, SOUTH SIDE OF CANAL.

New wall:		
Quantity of wall to be built July 1, 1900	cubic yards..	3,704.0
Quantity of wall added on account of revised estimate of November 10, 1900	cubic yards..	96.8
Quantity of wall to be built July 1, 1901	do....	3,800.8
Slope revetment:		
Quantity to be paved July 1, 1900	square yards..	3,570.0
Quantity deducted on account of revised estimate submitted November 10, 1900	square yards..	1,204.3
Quantity to be paved after above deduction	do....	2,365.7
Quantity paved from July 1, 1900, to June 30, 1901	do....	0.0
Quantity to be paved July 1, 1901	do....	2,365.7
Old dry wall:		
Quantity to be removed July 1, 1900	cubic yards..	434.4
Quantity removed from July 1, 1900, to June 30, 1901	do....	0.0
Quantity to be removed July 1, 1901	do....	434.4
Old abutment:		
Quantity to be removed July 1, 1901, as per estimate submitted November 10, 1901	cubic yards..	1,301.8
Rock excavation:		
Old Section 3, G. & G.—		
Quantity to be drilled, blasted, and removed July 1, 1900	cubic yards..	13.0
Quantity added on account of revised estimate of November 10, 1900	cubic yards..	156.0
Total		169.0
Quantity drilled, blasted, and removed from July 1, 1900, to June 30, 1901	cubic yards..	0.0
Quantity to be drilled, blasted, and removed July 1, 1901	do....	169.0

East of Cross Dam:

Drilling and blasting was carried on from time to time by drill scows Nos. 1 and 2 from July 1, 1900, to November 24, 1900, when both scows were laid up on account of the low stage of the river.

Work accomplished:		
Quantity to be disrupted July 1, 1900	cubic yards..	28,609.9
Quantity added on account of revised estimate submitted November 10, 1900	cubic yards..	3,251.1
Total	do....	31,861.0
Quantity disrupted from July 1, 1900, to June 30, 1901	do....	14,007.7
Quantity remaining to be disrupted July 1, 1901	do....	17,853.3

Number of holes drilled	4,534
Number of holes blasted	9,048
Linear feet drilled	18,914
Linear feet blasted	37,335

Of the above there were 5,229 holes cleaned out, loaded, and blasted that were drilled in 1898.

	Aggregate length drilled and blasted.	Average depth of holes.	Depth of water over rock.	Average rate per day of eight hours for one drill.	Cost per linear foot for drilling and blasting.	Cost per linear foot for cleaning out, loading, and blasting old holes.	Dynamite per cubic yard of rock blasted.
	Lin. feet.	*Lin. feet.*	*Feet.*	*Lin. feet.*	*Cents.*	*Cents.*	*Pounds.*
Submarine drilling and blasting	17,671	4.63	3 to 6½	38.4	16.4	6.42	1.4

Cost per cubic yard of rock disrupted..........cents.. 94.16

The above cost per cubic yard includes the cost of drilling and plugging done in 1898.

Removing disrupted rock:

Dredge *Louisville No. 1* was engaged removing disrupted rock eight days; dredge *Louisville No. 2*, seven days; derrick boat No. 1, three days, and derrick boat No. 2, six days.

Work accomplished:	Cubic yards.
Quantity of rock to be removed July 1, 1900	33,375.7
Quantity added on account of revised estimate submitted November 10, 1900	3,251.1
Total	36,626.8
Quantity removed from July 1, 1900, to June 30, 1901	1,607.0
Quantity remaining to be removed July 1, 1901	35,019.8

Of the above, 448 cubic yards were removed by derrick boats and stored north of new north canal wall to be used for backing in proposed new south wall.

Cost per cubic yard of disrupted rock removed $1.0132

The cost of timber, coal, and one horse, an aggregate of $3,171.92, is not included in the above cost per cubic yard, for the reason that they are still on hand and available for future use.

UNDER CROSS DAM.

Disrupting rock: Drilling and blasting was carried on by drill scows Nos. 1 and 2, from time to time during July and August, 1900.

Work accomplished:	Cubic yards.
Amount to be disrupted July 1, 1900	1,153.6
Amount added on account of revised estimate submitted November 10, 1900	725.2
Total	1,878.8
Quantity disrupted from July 1, 1900, to June 30, 1901	1,143.3
Quantity remaining to be disrupted July 1, 1901	735.5
Number holes drilled	554
Number holes blasted	454
Linear feet drilled	2,299
Linear feet blasted	2,073

	Aggregate length drilled and blasted.	Average depth of holes.	Depth of water over rock.	Average rate per day of 8 hours for 1 drill.	Cost per linear foot for drilling and blasting.	Dynamite per cubic yard of rock blasted.
	Linear ft.	*Linear ft.*		*Linear ft.*	*Cents.*	*Pounds.*
Submarine drilling and blasting	2,073	....	3 to 6¼ feet.	81.9	17.2	1.44

Cost per cubic yard of rock disrupted, 80.4 cents.

UNDER CROSS DAM.

Removing disrupted rock: Dredge *Louisville No. 1* was engaged three days in March, 1901, dredging disrupted rock.

Work accomplished:	Cubic yards.
Quantity of rock to be removed July 1, 1900	2,200
Quantity added on account of revised estimate submitted November 10, 1900	725.2
Total	2,925.2
Quantity removed from July 1, 1900, to June 30, 1901	159
Quantity remaining to be removed July 1, 1901	2,766.2

UNDER GUIDING DIKE.

Disrupting rock: The work of disrupting rock under guiding dike was practically completed June 30, 1900, but after dredging over area blasted, a small area was discovered to be from 1 to 3 tenths above grade. There was also a small area discovered to be projecting above grade from 1 to 4 tenths just south of the dike. Both of the above places were drilled and blasted to grade.

Work accomplished:

Number of holes drilled	171
Number of holes blasted	120
Linear feet drilled	640
Linear feet blasted	498
Quantity of rock disrupted	71.7 cubic yards

UNDER GUIDING DIKE.

Removing disrupted rock.—The work of removing disrupted rock under guiding dike was carried on from time to time by dredges *Louisville, Nos. 1* and *2*, dredge *Wabash*, and by derrick boats Nos. 1 and 2.

Dredge *Louisville No. 1* was engaged in July from the 1st to 26th, and on the 31st; August 1 to 31, September 1 to 16, and 21 to 31; October 1 to 14, and laid up for repairs from the 15th to 31st; November from the 1st to 21st, and 24th to 31st; December on the 29th, January 4 and 5, and 14 to 16, laid up for repairs from 6th to 13th. February 11 to 16, and 25 to 28, and laid up for repairs from the 1st to 5th, and 17th to 24th.

Dredge *Louisville No. 2* was engaged in July from the 1st to 8th, September 22 to 30, October from 1st to 9th, and in November from 16th to 20th.

Dredge *Wabash* was engaged in July from 1st to 17th, 21st, and from 25th to 31st; August 1 to 11, and from 16th to 31st; September 1 to 8, after which she was laid up to have her machinery repaired and transferred to new hull. The work of repairing and transferring machinery was completed and the dredge at work on the 31st of October removing disrupted rock under guiding dike, where she remained during November, except when laid up for repairs.

Derrick boat No. 1 was engaged in July from the 1st to 12th, on the 21st and from 25th to 31st; August from 1st to 31st, with exception of two days on canal work, and from 1st to 31st of September.

Derrick boat No. 2 was engaged from the 1st of August to the 22d of September.

	Cubic yards.
Amount of rock remaining to be removed July 1, 1900	4,180.8
Amount of rock removed from July 1, 1900, to June 30, 1901	11,548.7
Amount of rock removed in excess of estimate	7,367.9

The above amount in excess of estimate was caused by dredging below grade and a large quantity of loose rock just north of old guiding dike which was covered with mud deposit.

NEW HULL AND REPAIRS TO DREDGE WABASH.

This work was carried on at Louisville and Portland Canal dry dock and shops. The new hull was built, all repairs to machinery completed, and machinery transferred.

The work was started September 8 and completed on the 31st of October, 1900.

Expense.

Material:

Castings	$280.53	
Lumber	1,807.03	
Dredge boom	799.00	
Turntable	308.36	
Miscellaneous	163.89	
Total		$3,358.81

Labor:		
Carpenter work	$1,307.15	
Machine work	314.38	
Iron work	412.09	
Painting	39.75	
Caulking	184.65	
Transferring and setting up machinery	280.15	
Patterns	33.13	
Total labor		$2,571.30
Amount expended previous to July 1, 1900, as per annual report of June 30, 1900		1,596.77
Total cost of labor and material		7,526.88

REMOVING GUIDING DIKE AND CROSS DAM.

Guiding dike. –The removal of guiding dike was completed on the 29th of September, 1900.

Quantity of guiding dike removed, 108 linear feet, 268.8 cubic yards.

Cross dam.—The work of blasting out cross dam was supposed to have been completed, with the exception of a part of the north wing abutment, but while drilling ledge under dam it was discovered that there were some timbers remaining which it was necessary to remove.

Concrete dam.—After the high water in 1900, on account of defective concrete it was found necessary to repair the first two 50-foot sections that were built.

Quantity of concrete mixed and placed, 35 cubic yards.

GUIDE BUOYS.

The drawings and patterns for five steel-spar guide buoys and anchors were completed. The buoys and anchors were purchased and one placed at about canal station 123 + 50, to mark the north channel line of basin or south line of excavation.

Very respectfully, your obedient servant,

J. H. Casey, *Assistant Engineer.*

Capt. Wm. L. Sibert,
Corps of Engineers, U. S. A.

REPORT OF MR. GRANVILLE W. SHAW, ASSISTANT ENGINEER.

United States Engineer Office,
Louisville, Ky., June 30, 1901.

Captain: I have the honor to submit the following report of operations on improving falls of the Ohio River, Indiana Chute, for the fiscal year ending June 30, 1901:

WAVE ROCK.

The river remained too high for operations at Wave Rock until July 17, on which date a compressor boat with its drills and crew was taken from the head of the canal and anchored in approximately the same position as last season. From the 17th to the 23d a small force was employed in transferring tools and material from the warehouse near Eighteenth street, and in laying the main pipe line and branches. Drilling by compressed air was commenced on the 24th. The office boat was taken over to the chute on the 23d, and on the 27th a 25-horsepower boiler was transferred from the warehouse, to be used for steam drilling in the borrow pit. Barges were overhauled and calked and necessary lumber for temporary sheds taken to Goose Island. Air drilling on the upper end of Wave Rock was completed on August 2 and the compressor plant transferred to work on the canal. The river continued high, and drilling at the borrow pit was not begun until August 24. Excavation at Wave Rock was not begun until September 11, on which date a force of 24 laborers and 4 teams began removing the loose material along the face of the cut. Blasting on the higher ledges was begun on September 13, and on the 21st a force of hand drillers began work on the high points of the lower ledge. A shelter shed capable of accommodating 32 teams was erected on Goose Island. Excavation at the borrow pit was begun on September 15 and the material placed in the dike.

Excavation at Wave Rock continued until October 29, when a rise in the river submerged the grade plane and operations were suspended. Beginning with October 1, the material excavated at Wave Rock, except that carried directly to the dike, was stored on the high portion of the island south of the line of excavation, with a view to its being used in the dike at a higher stage in the river than was possible if taken directly from the cut. Excavation at the borrow pit was continued until October 22, and steam drilling until October 27. The main cut was practically completed back to the line of excavation on October 23, leaving only limited areas on the lower plane ranging from 0.2 to 0.9 of a foot above grade. On November 5, the river having fallen, hand drilling was resumed and continued until the 10th, when another rise interfered. On the 12th, work was again attempted and the drilling was finally completed on the 15th. Excavation was carried on when the stage of the river would permit and completed on November 18. On November 21 the work was practically suspended for the season. It is estimated that there were excavated and removed from Wave Rock during the season 16,328.64 cubic yards, and from the borrow pit 5,764.20 cubic yards, both measured loose, making a total of 22,092.84 cubic yards placed on the dike and approaches and in the storage dump. The latter is estimated to be 3,596.6 cubic yards, loose. There were drilled at Wave Rock and the borrow pit, steam and air, 1,820 holes, aggregating 8,875 linear feet, and by hand 5,959 holes, aggregating 7,637 linear feet. The total cost of excavation at Wave Rock and borrow pit was $24,480.69, about $1.10 per cubic yard. The cost of drilling was as follows: By steam and air, 21.2 cents; block holes, 9.7 cents; by hand 47.1 cents per linear foot. There were used 8,463 pounds of dynamite.

WILLOW POINT.

At the end of the previous season it was estimated that there were remaining to be removed at Willow Point 4,278.35 cubic yards, measured loose. The season of 1900 was particularly unfavorable for work at this point. The partial construction of the Wave Rock dike had reduced the width of the channel, so that it took an extreme low stage to uncover the grade plane—Ref. 19. On the 10th of September a small force of laborers was employed in making necessary repairs to the dike below Willow Point. The lower end was practically repaved, and about 228 square yards were repaired on the south side. On the 17th it was decided to inclose the area to be excavated with a small earth dam. This was done with gunny bags filled with clay, backed with earth, and protected on the outside with quarry spawls. A 10-horsepower boiler and steam pump was installed on the 22d, and teams were loaded with the loose stone remaining from the previous year's work. The dam was submerged by a rise on the 24th. Work was resumed on the 29th and excavation begun. Work was continued until October 24, when the excavation was completed. A night force was employed from October 10 to October 17. The principal features of the work were the exclusion of water which came up through the drill holes, and the removal of a considerable area only a few inches above grade. Although the drilling was carried at least 1 foot below grade, the blasting frequently blew out circular holes instead of tearing up the bottom, which made redrilling necessary. Tools and appliances were stored on the bank and the force discharged on October 25. All appliances were loaded on barges and removed to the warehouse on the canal on the 21st.

Excavated material was stored north of the dike, where it will be available for future work. It is estimated that there were excavated and removed during the season 6,846.2 cubic yards of rock, measured loose.

There were drilled with a small Kid drill 343 holes, aggregating 494 linear feet, and by hand 2,079 holes, aggregating 3,430 linear feet.

The total cost of the work at Willow Point was $9,752.54, or $1.27.8 per cubic yard. The cost of hand drilling was 50.4 cents, and block holing 19.3 cents per linear foot. There were used 14,683 pounds of dynamite.

WAVE ROCK DIKE.

The base of Wave Rock dike was submerged until September 12. When the river fell a break was disclosed near its junction with Goose Island, and there was more or less wear for the entire length due to ice and drift during the winter months. On September 12, excavated material was hauled from the cut at Wave Rock, and the work of restoring the base to its proper grade was begun. On the 13th, material from the borrow pit was used to repair approaches to the dike, and later to restoring the base. Repairs to the base were completed on September 24, and the work of rebuilding the lower section of the dike proper was begun. This section, about 4 feet high, was completed October 24, and work on the upper section was begun with one-horse carts at once. The work of building and paving the dike was continued until November 20, when operations were suspended for the season.

At the close of the season the following work had been accomplished: The base rebuilt to grade; the lower section of the dike proper built and paved; 87 linear feet built to full height and completely paved; 97 feet filled to full section and paving completed to spring line of arch; 783 feet built to full section and north slope paved to spring line; 394 feet partly built and south slope paved to spring line; about 300 feet of the upper end of dike, on top of Goose Island, partly built, and lower portion of slopes laid in cement. It is estimated that 1,667.6 cubic yards, measured loose, were used in repairing the base of the dike, which is equivalent to the loss during the winter months. It is estimated that there were placed in dike, road, and approaches 18,496.2 cubic yards of stone, measured loose. The cost of building dike was $8,991.30, or 48.6 cents per cubic yard.

During December an inspection of the dike disclosed a break near the upper end about 350 feet long, which will require about 1,300 cubic yards of filling to replace. It is estimated that it will require about 3,000 cubic yards of filling in addition to the above 1,300 cubic yards to complete the dike. There will also be about 7,100 square yards of paving, the whole being estimated to cost $9,207.

CHANNEL ABOVE RAILROAD BRIDGE.

Preparations for beginning work on the remaining portions of Left Hand Reef were begun on September 15, and the first crib of a breakwater at the head of the reef was placed in position on the 20th. The upper end of the reef was surrounded by 32 cribs, reducing the water in the interior about 18 inches, and exposing the ledge for drilling. Drilling by hand was commenced on October 2 and blasting and sledging on the 3rd. The entire area, about 1,600 by 50 feet, was drilled, blasted, and excavated between October 2 and 25. By the use of temporary cribs an expensive dam across the head of the chute was avoided. There were drilled 2,930 holes, aggregating 5,662 linear feet. Fifty-eight blasts were discharged, using 2,096 pounds of 75 per cent dynamite. On October 31 all property, tools, and employees were transferred to the work at Wave Rock. It is estimated that 2,623 cubic yards, measured loose, were removed from the reef. The total cost of work was $8,391.34, or $3.19.9 per cubic yard.

CROSS DAM AT HEAD OF FALLS.

On August 21 a master laborer and 6 men began loading timber at the Fourteenth street yards for the repair of the cross dam at the head of the falls. Work was begun immediately north of the Middle Chute on the 24th, but a rise in the river compelled a suspension of operations until August 30. On the latter date work was resumed and the repairs completed October 20. The work consisted in the removal of decayed timbers, refilling cribs, and the placing of new decking when necessary. The Boulé Dam, Indiana Chute, was raised and inspected. The trench was found to be filled with loose stone, which was removed and the dam lowered. The cost of the repairs was $875.17.

Very respectfully, your obedient servant,

GRANVILLE W. SHAW,
Assistant Engineer.

Capt. WM. L. SIBERT,
Corps of Engineers, U. S. A.

J J 2.

OPERATING AND CARE OF LOUISVILLE AND PORTLAND CANAL, KENTUCKY.

* * * * * * *

The details of the year's operations, together with commercial statistics, are fully set forth in the report of Mr. J. H. Casey, assistant engineer, appended hereto, and to which attention is respectfully invited.

Following are statements of expenditures, collections, etc., for the year.

Summary of expenditures on account of operating and care of Louisville and Portland Canal, fiscal year 1901, showing general items and amount expended under each heading.

Item.	Amount.
Services	$58,168.31
Supplies	6,764.79
Materials	9,881.41
Miscellaneous	515.58
Total	75,330.09

Collections.

1900.		
July 10.	William Orms, for use of dry dock	$48.75
Sept. 17.	K. and I. Bridge Company, for use of dry dock	278.33
Sept. 22.	Speed Elevator Company, for rent of land	125.00
Dec. 4.	Proceeds of auction sale	170.20
1901.		
Jan. 3.	Louisville Cement Company, for rent of land	30.00
Jan. 16.	Union Cement and Lime Company, for rent of land	5.00
Jan. 26.	J. T. Duffy & Co., for removal of wrecked boat	99.39
Mar. 15.	Speed Elevator Company, for rent of land	125.00
	Total	881.67

All of the above collections were deposited to the credit of the Treasurer of the United States.

REPORT OF MR. J. H. CASEY, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
LOUISVILLE AND PORTLAND CANAL,
Louisville, Ky., July 6, 1901.

CAPTAIN: I have the honor to submit the following report of operations for operating and care of Louisville and Portland Canal during the fiscal year ending June 30, 1901:

REGULAR FORCE.

During the year the canal was open to navigation 339 days and closed 26 days—on account of high water 2 days in December, 14 days in April, 4 days in May, and 3 days in June.

The highest stage of water occurred April 28–29, when the upper gauge read 33.2 feet and the lower 58.8 on the 28th and 58.9 feet on the 29th.

The lowest stage was on September 6, the upper gauge reading 2.2 feet and the lower 3.4 feet. On November 1 and 2 gauge read 2.9 feet.

The lock force operated gates and passed boats through locks and did the following miscellaneous work: Weeded revetments and slopes; trimmed hedge from Twenty-sixth to Twenty-eighth streets; repaired engine foundation, lower gate, north side; cut grass and weeds on slopes; repaired roadways north and south side of canal leading to lock middle houses; suspended automatic gate from timbers on walls for the purpose of cleaning and painting gate, and placed iron protectors in front of gate wickets; grouted revetments; repaired electric-light engine and lamps; put anchor bolt for suspension chain at upper gate, north side; replaced worn-out chain on guard gates, old canal, with old dredge chain; assisted in placing new stacks on north middle engine house and put new hose plug on south side of canal top of slope near upper engine house; dug up old floors in middle engine houses for new cement pavements; prepared gates and cared for property during high water; washed mud from walls, houses, slopes, and gates after each high water, and made such repairs to machinery as were necessary; operated automatic gate 467 hours during the year.

Since the gate was put in operation, June, 1899, with the exception of Twenty-eighth street basin at the new locks, no dredging was done in the canal between Fifteenth street and the old locks. Heretofore, as near as can be estimated, the dredging in this part of the canal alone cost $5,000 per year. When the stage of river will permit, after each rainfall and high water the gate is lowered to scour out the sewage and mud deposits. The gate is also found useful in passing out drift and ice. During the past winter the strong current broke up the ice along the entire length of the canal.

On January 17, during a coal run, the boiler at middle engine house north side of the canal sprung a leak, which necessitated putting a patch on smoke and fire box. In order not to cause delay to coal run during repairs, compressor boat No. 1 was brought to basin east of Twenty-eighth Street Bridge, line of pipe laid to and connected with lock engines, and the gates of north side of canal were operated satisfactorily by compressed air from 3.35 p. m. on the 18th to 22d, when repairs to boilers were completed.

The regular force in blacksmith, carpenter, and machine shops made necessary repairs to boats, buildings, dredges, and worked on other work required for Falls of Ohio River and Green and Barren rivers.

The following tables show amount of traffic and commerce passed through the canal and over falls during the year:

COMMERCIAL STATISTICS.

Statement of vessels passed through the Louisville and Portland Canal during the fiscal year ending June 30, 1901.

Vessels.	Number.	Capacity.
Passenger boats	613	207,281
Towboats	948	109,786
Government boats	371	11,940
Coal boats and barges	3,287	946,244
Small craft	357	125
Rafts	5	160
Total	5,581	1,275,536

Lockages, 2,526.

Statement of commerce passed through the Louisville and Portland Canal during the fiscal year ending June 30, 1901.

Articles.	Tons.	Articles.	Tons.
Coal	937,743¼	Hay	2,124
Corn	1,081¼	Straw	3,175¼
Wheat	8,685¾	Cattle	1,827
Salt	1,704¾	Swine and sheep	1,655¾
Oil	1,024¾	Lumber	129,361
Whisky	628¼	Staves and shingles	21,179¼
Flour	480	Steel rails	33,796
Sugar	2,652¼	Iron ore and manufactured iron	8,574
Molasses	2,178¼	Produce	1,451
Cement	799	General and miscellaneous	50,095
Tobacco	2,814		
Cotton	3,533	Total	1,216,906

Number of passengers, 13,090.

Statement of commerce passing Falls of Ohio River via Louisville and Portland Canal and Indiana Chute during fiscal years 1886 to 1901.

Articles.	From 1886 to 1900, inclusive.	Fiscal year 1901.	Total for fifteen years.
Coal	20,522,461	1,842,779¾	22,365,240¾
Salt	118,897	5,466¾	124,363¾
Oil	59,529½	1,414¾	60,944¼
Whisky	20,544¾	897½	21,442¼
Tobacco	86,957¾	3,312¾	90,270½
Cotton	136,187½	4,075½	140,213
Lumber	3,264,209	136,812	3,401,021
Corn and wheat	141,457½	10,163½	151,621
Iron ore	490,082½	28,560	518,642½
Steel rails	610,561	74,621	685,182
Produce	82,239½	2,157	84,396½
Hay and straw	192,571¼	5,952¼	198,523½
Flour	19,232½	598	19,830½
Stock	94,532¾	4,421¼	98,954
Sugar and molasses	119,128¼	6,618½	125,746¾
Staves and shingles	453,599¾	21,711	475,310¾
Cement	39,332½	1,236¼	40,568¾
Miscellaneous	1,247,667	71,885	1,319,552
Total	27,699,141	2,222,682¾	29,921,823¾

Statement of vessels passing Falls of Ohio River via Louisville and Portland Canal and Indiana Chute from June 30, 1881, to June 30, 1901.

Kind of vessel.	1881 to 1900, inclusive.		1901.		Total for twenty years.	
	Number.	Tons.	Number.	Tons.	Number.	Tons.
Passenger boats	18,594	7,396,902	797	284,083	19,391	7,680,985
Towboats	22,365	3,009,201	1,568	213,777	23,933	3,221,978
Government boats	4,201	299,552	430	13,390	4,631	312,942
Coal boats and barges	77,118	24,269,879	4,830	1,584,544	81,948	25,854,423
Small craft	5,242	5,475	404	1,405	5,646	6,880
Rafts	73	3,018	8	852	81	3,870
Total	127,593	34,983,027	8,037	2,098,051	135,630	37,081,078

Annual average during the past twenty years: Boats, 6,781 +; tons, 1,854,053 +.

TOWBOAT AND DREDGES.

Towboat *Major Mackenzie* was employed towing mud scows, barges, dredges, etc., for the canal and for work at head of the falls. On November 5 began working day and night, and continued to March 10, when night work was discontinued on account of high water. The boat was laid up during the year as follows: July 1 to 26, waiting inspection of boilers by United States inspector; August 18 to 25, on account of cracked copper steam pipe; January 19 to 23, on account of leak in boiler; April 20 to May 5, on account of high water; and May 26 to June 30, to receive new battery of boilers and undergo general repairs and painting.

Steamer *Col. G. L. Gillespie* towed scows for dredges from July 1 to 30, August 21 to 25, and May 27 to June 30, while steamer *Major Mackenzie* was laid up for boiler inspection, repairs to steam pipe, and while receiving new battery of boilers.

On November 25 left in tow with dredge *Louisville No. 2* and one mud scow for work on Wabash River; returned to canal March 25.

Dredge *Louisville No. 1* was employed during the year dredging mud from canal between canal stations 1 and 110, and rock from head of canal for Falls of Ohio River as follows: July, August, September, October 1 to 13, November 1 to 28, December 29, January 4 to 16 and 24 to 31, February 1 to 5 and 11 to 28, and March 1 to 10. On January 21 and 22 dredged coal sunk in canal at station 25; was laid up on account of repairs to dipper bail and broken dipper handle from October 14 to 31; on account of broken step at foot of crane from December 6 to 13, and from April 20 to May 5 and June 3 and 4 on account of high water, and June 8 to 10 on account of repairs. Quantity of dredging done for canal was 37,880 cubic yards mud.

Dredge *Louisville No. 2*, a bucket and grapple dredge, was employed from July 26 to August 13 dredging mud from in front of retaining wall, unprotected bank, and placing same behind wall; dredged mud from canal between stations 1 and 100, east of guard gates, and 8 and 9, west of guard gates; worked at head of canal for Falls of Ohio River from July 1 to 10, September 22 to 30, October 1 to 26, and November 16 to 23. On November 25 left for Wabash River; returned March 25. Was laid up from July 13 to 16 on account of repairs to friction and hoisting drums, and from March 25 to May 2 on account of being out of commission, and June 12 to 14 on account of repairs.

	Cubic yards.
Quantity of mud dredged from canal	17,296
Quantity of mud dredged and placed behind retaining wall	1,370
Quantity of loose rock dredged from canal	75

The dredge *Wabash* worked on improvements for Falls of Ohio River from July 1 to 31, August 1 to 31, September 1 to 8, October 31, November 1 to 13, and 21 and 22, January 8 to 14, February 1, 2, and 17 to 20, and March 1 to 10.

Dredged in canal at intervals between November 14 to June 26, dredging 32,900 cubic yards mud.

On January 21 and 22 dredged coal sunk in canal at station 25. From September 9 to October 30 was transferring machinery from old hull to new hull; was laid up on account of repairs to dipper and machinery twenty-one days, and on account of high water from March 15 to 20, April 8 to 15, 21 to 30, May 31, and June 1 to 4.

Green River Dredge No. 1: Arrived at locks from Green River December 28 and began dredging in canal on 31, and continued to June 30, with the exception of time employed on work at head of canal for Falls of Ohio River, viz, January 21 to 31, February 1 to 28, and March 1 to 10. Was laid up on account of repairs, etc., nine days; on account of high water from March 17 to 19, April 8 to 14 and 21 to 30, May 1 to 5, and June 27 to 30.

Quantity of mud dredged in canal, 25,125 cubic yards.

The crews of boats raised wickets of Boule dam at head of canal December 17-19, lowered them January 15; raised them again January 24-25, lowered them February 5; raised them again February 15-16, lowered them March 9-10; raised them May 9-10, lowered them on 11th; raised them again on the 21st, lowered them on 23d.

Dredges *Louisville No. 1* and *Wabash* worked day and night from November 5 to March 10, and Green River dredge No. 1, from January 4 to March 10, when night work was suspended on account of high water.

EXTRA LABOR.

A small force was engaged off and on during the entire year doing the following miscellaneons work: Docked boats and barges; cleaned mud deposit from dry dock amounting to 900 cubic yards; removed old dry-dock gates from dock and placed same behind retaining wall, unprotected bank; made cross-ties and laid small rail-service track from top of slope east of carpenter shop, to dry-dock wall, for handling material used on shipyard slope and in dry dock; drilled holes and put in snubbing posts in north dry-dock wall; removed old timbers from shipyard; unloaded timber from barges received from Green River, hauled and stacked same in yard near carpenter shop; dismantled old dredge *Wabash*, power-boat *Osseo*, and old derrick boat; made current observations at head of canal, trimmed hedge, cut weeds and grass along canal bank north and south sides from Fourteenth to Twenth-sixth streets; also west of Twenty-eighth Street Bridge and in park; removed stone from south canal slope; changed telephone booth in canal office; made stationery, filing, and map cases for United States engineer office; made new screens and placed new bath tub in residence at locks; rebuilt porch at residence at Eighteenth street; tore down and removed old oil house south side canal east of Twenty-eighth Street Bridge; cut water gauge in wall at branch office, Ninth street and canal; fitted up mixing machine for testing cement; built wire fence across western end of park; washed mud from revetments and walls, and removed drift east of Twenty-eight Street Bridge which was left by high water; watched and cared for fleet laid up in basin at locks. A boiler and engine was brought from Fourteenth Street Warehouse and set up alongside carpenter shop to run machinery in planing and sawmill, to relieve the boiler in machine-shop engine room, which was inadequate to furnish power for both machine and carpenter shops. A temporary shed was built over boiler and engine to protect them from the weather.

MISCELLANEOUS, FUEL, OIL, ETC.

Under this heading necessary supplies were purchased for maintaining plant. During the year 89,769 bushels of coal were purchased for use on boats, locks, and in shops and improvements at head of canal, and unloaded from barges into coal bin and on canal wall.

MISCELLANEOUS REPAIRS.

Steamer *Major Mackenzie:* Turned packing rings for valves; put new pillow block in wheel; made patterns for kevil and snatch block. Between August 18 and 25 Messrs. Gargan & Co. made new 80-pound copper steam pipe and placed same in position to replace cracked one. Repaired capstan, exhaust pipes, throttle valve, rudder irons, and made bolts for wheel flanges. May 26 was laid up to receive new battery of boilers built by Messrs. John Mitchell & Co., of Louisville, Ky. While the boat was laid up, the following repairs were made: Built entire new head, new knees, new outriggers from stem to stern, new nosing and plank-sheer, new smoke-stacks; repaired deck where required, remodeled capstan, and painted boat inside and outside. On June 18 was placed on dry dock to have bottom plank replaced and calked, but owing to a rise in the river the boat was floated the next day and was compelled to remain off dock to June 30.

Steamer *Col. G. L. Gillespie:* Calked hull above water line; made hatchways and repaired stage plank, pillow block, wheel, cut-off valve, and braced cylinder timbers and lined up engines.

Dredge *Louisville No. 1:* Repaired dipper, dipper handle, siphon, rear spud shaft and gearing, frictions, and bored and faced spur wheel; took crane off dredge and repaired same and made pattern for crane step.

Dredge *Louisville No. 2:* Repaired frictions, hoisting drums, sheaves, lubricators, pump, arm of Lancaster grapple, spud, exhaust pipe, and calked and repaired boiler.

Dredge *Wabash:* Replaced broken turntable with one from old boat; repaired hoisting machinery, swinging engines, capstan engines, drum-shaft bearings, worm wheel, and expanded flues. Made drum pattern and rebuilt old dipper and made repairs to same.

Green River Dredge No. 1: Repaired crane, dipper, pillow blocks, boiler, and made new dipper handle.

Placed scows and barges on dry dock and made minor repairs from time to time as required; made new wooden gates and placed same at each end of Eighteenth Street Bridge; replaced two worn-out wheels under Eighteenth Street Bridge; painted interior of bridge tender's residence, and repaired water pipes across bridge.

Replastered ceiling in drafting room, and painted screens for canal office. Repaired throttle valve and put new fire-liners in furnace in machine shop; repaired roadways about shops and at coal bin; repaired trestle, platform, and floor, and painted roof and sides of coal bin; painted roof of machine and blacksmith shops.

The south canal wall at station 66 hung over the rock ledge, and the pressure of slope behind same caused the wall to gradually slide from foundation, which necessitated the removal and relaying of 46.94 cubic yards of masonry; excavating 7 cubic yards of earth and 1.5 cubic yards of rock.

Repaired bed to cart and top and wheels of spring wagon; replaced worn-out chock for towing engine on lock wall, smokestack at middle engine house, north side; repaired iron rack in warehouse, floor of Twenty-sixth Street Bridge; fence around office and west end of park, injector for compressor boat No. 1, and electric-light engines, dynamo, and lamps at locks; fitted crosshead brasses to engines at locks; repainted signs for branch office; made apron; repaired sheaves and placed new boom on derrick boat. Repaired fenders of lock gates; made new water valleys for lower engine houses; drilled hinge lugs and made new wickets and repaired old ones for Boule dam, and made other minor repairs.

DRY-DOCK GATES.

These gates were the lower lock gates, which were replaced with new ones during 1897–98. The amount allotted was for making necessary alterations, so they could be used for dry-dock gates.

During November the gates were removed from dry dock, where they had been lying for two years, placed on blocking, and upon examination it was found that on account of being exposed in the air for so long it was necessary to replace both toe posts, one heel post, and portion of the second heel post and decking. New timbers were purchased for heel and toe posts, the decking being made from lumber saved from cofferdam used at dry-dock wall.

New miter sill was put in, bolted down, and 41.9 cubic yards concrete placed in front and behind same.

One gate was launched January 18; the other on the 24th. The blacksmith and machine shop forces worked on straps, suspension chains, and cast-iron columns, doing all iron and machine work preparatory to erection. Four 6-foot and two 8-foot anchor holes were drilled for gate columns and anchors fastened therein with Portland cement.

During January the gates were set up and all connections made, and between February 1 and 10 all of the decking was placed on gates and wickets fastened in position.

RETAINING WALL, FRONT OF UNPROTECTED BANK.

The work done under this heading was completing the retaining wall in front of unprotected bank in accordance with estimate submitted June 18, 1896. The work was carried on as in previous years by hired labor. On August 13 began setting stone and completed all of the wall proper on September 27. A derrick boat used in connection with laying stone was docked, hull repaired and calked, and machinery overhauled.

During July and August, 12 carloads of stone, or 210.88 cubic yards face stone, were received on railroad switch, Eighteenth and Canal, from Messrs. Zellers & Thomas, of Cloverport, Ky., unloaded by derrick boat onto barges and transferred to site of work.

Dredge *Louisville No. 2* worked July and August dredging mud, which was used as a dam, while putting in foundation courses in front of wall between stations 12 and 29, placing same behind wall.

To facilitate the delivery of stone for concrete backing, a chute was built from roadway on top of bank to wall, where the stone was transferred from carts onto barge, there mixed and placed in forms back of wall with derrick. Concrete filling commenced August 28 and was completed October 3.

Between April 9 and June 30 a force of laborers was employed loading earth deposited by high water from south canal wall, west of Ninth and Fourteenth streets, onto barges; the barges were then towed to retaining wall, earth unloaded, and used as earth filling behind wall.

From September 6 to 20, gathered broken stone along south canal bank and filled same in behind wall.

The following is the quantity of work done during the year:

	Cubic yards.
Masonry laid	340.71
Concrete placed behind coping	216.16
Broken stone placed behind wall	190.00
Mud filled behind wall, with dredges	1,370.00
Earth filled behind wall, by hand	6,803.80
Cost per cubic yard masonry laid	$7.50
Cost per cubic yard concrete backing	3.09
Cost per cubic yard broken-stone filling	.603
Cost per cubic yard earth filling	.081

Total amount of work done under estimate of June 18, 1896, from October, 1896, to June 30, 1901, and cost of same is as follows:

	Cubic yards.
Masonry laid in wall	5,566.50
Concrete placed behind coping	216.16
Earth and rock excavated	5,177.93
Earth and mud filled in behind wall	15,261.80
Broken rock filled in behind wall	1,651.56

Cost.

1,776.61 cubic yards stone purchased, at $4.48 per cubic yard	$7,959.21
210.88 cubic yards stone purchased, at $5.25 per cubic yard	1,107.12
Labor, setting 5,566.40 cubic yards stone in wall, at $1.64	9,144.76
Labor, unloading 1,987.49 cubic yards from cars, at 31.2 cents	620.24
Labor, laying tracks for handling stone, etc	184.74
1,188.11 cubic yards sand used in wall, per cubic yard of masonry, at 11 cents	611.05
3,136 barrels cement used in wall, per cubic yard of masonry, at 37 cents	2,044.87
Material used on boats, etc	541.07
Broken stone purchased for concrete	153.53
Labor, mixing 216.16 cubic yards concrete and placing same behind coping, at 24.3 cents	526.27
Labor, earth and rock excavation, 5,177.93 yards, at 54.6 cents	2,829.92
Labor, rock filling behind wall, 1,651.56 yards, at 44.5 cents	735.62
Labor, earth filling behind wall, 15,261.80 yards, at 21.4 cents	3,279.17
Total cost	29,737.57
Cost per cubic yard of masonry laid	$4.114
Cost per cubic yard of earth and rock excavated	.546
Cost per cubic yard of rock filling	.445
Cost per cubic yard of earth filling	.214

All of the backing for the above work was taken from the excavation in new basin at head of canal.

NEW BOILERS FOR THE MAJOR MACKENZIE.

When the boilers on the *Major Mackenzie* were inspected by the local inspector July 26, 1900, they were found to be in poor condition, and the inspector recommended that they be either rebuilt or replaced with new ones.

Bids were invited under circular notice dated December 24, 1900, for one battery of three marine boilers, 40 inches diameter, 24 feet long, each having six riveted flues, two 6, and four 8 inches in diameter, the boilers to stand 200 pounds per square inch working steam pressure after a rigid inspection and test by the United States local inspector under the United States laws.

The contract was awarded to Mr. John Mitchell, Louisville, Ky., the lowest bidder for furnishing all material and setting boilers up in working order, for the sum of $2,315. On May 26 the boat was laid up and work of tearing out old boilers commenced, and by June 29 the contract was completed with the exception of fitting up one 29-foot exhaust pipe and inspecting boilers.

CRANK SHAPER.

One 20-inch back-geared shaping machine was purchased from the Cincinnati Shaper Company, under circular notice dated August 6, 1900, at a cost of $330. The machine was received August 27 and set up in machine shop during September. Heretofore all of the keyseating, etc., has been done on a planer, but with this machine it is now done more economically.

RETAINING WALL, DRY DOCK.

The work under this head during the year was completing the north dry-dock gate masonry at dry dock. During July a derrick was erected on top of pier head at old locks to handle stone, etc., and 164 cubic yards sand unloaded and stored on south canal wall. On August 17 began tearing out old north dry-dock wall above water. To complete wall it was necessary to build a cofferdam from north pier of old locks across and in front of dry dock to south abutment.

On September 11 began framing timbers for dam, and on the 25th commenced to assemble them together, and by October 10 the dam was completed and 543 cubic yards dirt filled in same. The blacksmiths made tie rods, etc., for holding dam together. During September derricks were erected in dry dock, tracks laid, old miter sill removed, and on the 29th the south dry-dock gate was thrown down and pulled out of the way. October 13 began laying stone in north pier, and continued to 30th, when work was temporarily interrupted on account of leak in dam, which flooded the dock. By November 14 the work was far enough advanced to lay stone in wall from derrick boat, and on account of slight rise in river, all derricks, tracks, etc., were removed from dock, water let in, and dam torn out, saving all the lumber.

Stone was laid in wall from derrick boat from November 14 to January 9, when all of the gate masonry was completed. For the upper retaining wall at dry dock, 62 linear feet of coping stone was cut and laid in same.

The following is quantity of work done during the year:

	Cubic yards.
Masonry laid in wall	1,132.42
Earth and rock excavated	2,242.03
Earth filled in cofferdam	543.00

Total amount of work done and cost of same, under estimate submitted June 11, 1895, from July 1, 1895, to June 30, 1901, is as follows:

Masonry laid in wall	cubic yards..	3,848.12
Earth and rock excavated	do....	10,525.23
Sod cut and laid on slope	square yards..	175.00
Earth filled in dam	cubic yards..	543.00

Cost.

1,258.67 cubic yards stone, at $4.48		$5,638.85
Labor unloading 1,258.67 cubic yards stone, at $0.197		249.06
Cement used in wall, per cubic yard of masonry, at $0.369		1,422.00
Labor, breaking 223.91 cubic yards stone, at $0.45		100.76
164 cubic yards sand used in wall, per cubic yard of masonry, at $0.029		114.80
Material, fuel, etc., used while setting stone		86.39
Labor, setting 3,848.12 cubic yards stone, at $2.77		10,692.70
COFFERDAM.		
Labor, building	$1,115.03	
Lumber used in building dam	555.01	
Nails, nuts, washers	18.31	
Iron for making bolts, etc	96.24	
		1,784.59
		20,089.15
Labor, earth and rock excavation, 10,525 cubic yards, at $0.51		5,368.81
Labor, sodding 629 square yards slope, at $0.15		94.37
Watching fleet, etc		61.71
Total cost		25,614.04
Cost per cubic yard of masonry laid		5.236
Cost per cubic yard earth and rock excavation		.51

NEW PAVEMENT, NEW LOCK.

The estimate for this work provided for cement pavements along cinder walks between middle and lower engine houses north and south side of canal, and alongside the lower lock; also to replace worn natural-cement pavements in middle engine houses with Portland-cement pavements.

The old pavements in engine houses were cut down 2 inches and replaced with a pavement of one part Nazareth Portland cement and one and one-half parts sand.

The foundation for pavement alongside lower lock was constructed with 7½ inches clean cinders, thoroughly watered and rammed to even surface, upon which were placed 3½ inches concrete, composed of one part Nazareth Portland cement, three parts clean sharp sand, and five parts broken stone, not to exceed 2 inches in diameter. This was thoroughly rammed to an even surface, and a wearing surface 1 inch in thickness placed on same, consisting of one part Portland cement and two parts clean sharp sand.

The United States did the excavating and furnished all of the cement. A contract was made April 22 with Charles F. Fitch for concrete pavement alongside lower lock at 67 cents per square yard, and for pavement in lock engine houses at 47 cents per square yard. Work of laying pavement on south side of canal was commenced June 10 and all the work completed June 29.

Total number cubic yards pavement laid in engine houses	320.49
Total number cubic yards pavement laid alongside lower lock	490.82

COST.

Contract price	$516.73
Material	553.85
Labor	116.08
	1,186.66

CANAL DRY DOCK.

Owing to the building of dry-dock gate masonry and putting in new gates, the dock was only available for about six months during the year. It was occupied thirty-four days and three hours by eighteen Government boats and by one sawmill and one ferryboat thirty-one days and seventeen hours.

ACCIDENTS IN CANAL.

On January 20, 6.45 a. m., steamers *W. W. O'Neal* and *John Moran*, while entering head of canal with tow of 20 loaded coal boats and 2 barges loaded with steel rails, the property of the Monongahela River Consolidated Coal and Coke Company, sunk one coal boat by grounding on the rock north side of channel, opposite station 108. The wreck was removed by its owners.

On January 20 steamer *Defender*, while bringing a tow of coal to locks, sunk a coal barge at station 25. The accident was due to carelessness on the part of the crew in allowing the barge to fill with water. The Monongahela River Coal and Coke Company made arrangements whereby the canal dredges were to dredge the coal and wreck, they paying for same. Dredges *Louisville* and *Wabash* removed the wreck on the 21st and 22d.

January 17 steamer *Transit*, while entering the canal, 8.30 a. m., in tow with three coal boats, one barge, and one flat of coke, struck the coke flat against the south wall, east of old guard gates, and knocked a rake plank off, causing the flat to take water and sink in middle of canal, opposite station 90. The wreck was removed by its owners, the Monongahela River Coal and Coke Company.

January 21, 12.10 p. m., while the steamer *Wash Gray* was entering the canal in tow with a large model barge of steel rail, she ran into a barge of coal at station 98, about 60 feet from north wall, causing said barge to sink. The coal and wreck were removed by the owners, the Monongahela River Consolidated Coal and Coke Company.

WORK DONE AT CANAL FOR FALLS OF OHIO RIVER.

Steamer Major Mackenzie.—Made patterns and repaired engines, wheel flanges, rudder irons, check and throttle valves, and got out timbers for wheel repairs.

Steamer Col. G. L. Gillespie.—Made valve for steam chest, repaired cam yokes and packing rings, engines, and wheel, and made new slide brasses.

Dredge Louisville No. 1.—Repaired chains and turned pins for endless chain;

repaired dipper and turnbuckles; made new dipper handle and new roller for top of crane; bored backing drum, and placed same in position.

Dredge Louisville No. 2.—Repaired Green River grapple, bored and turned sheaves, and calked boiler.

Dredge Wabash.—Repaired swinging engines, boiler, dipper, dipper handle, and crane; made new spud shafts, new dipper; repaired capstan engine, spud hoisting machinery, and keyseated gearing on swinging engines. The hull of dredge belonging to Wabash River was in such condition as to require new wooden hull to be built, which was done at our ship yard by hired labor, was launched on August 17. The boat was laid October 8 to transfer machinery to new hull, which work was completed and boat put in commission on the 31st.

Made new rollers for mud scows; repaired safety valves on steamer *Wave Rock;* docked and calked mud scows Nos. 1, 2, and 3 and small flat; painted Fourteenth street warehouse; removed boiler from old power boat *Osseo,* and placed same in position in new hull; made loading sticks, patterns for buoys, buoys and ring bolts for anchors, and placed same at head of canal; expanded flues and repaired roof of steamer *Wave Rock*; assisted in taking current observations, head of canal; repaired current meter; repaired roof and stacks of compressor boats; repaired dynamite tester, and overhauled machinery on compressor boats.

Repaired crane, shaft and bearings, pitman brasses, and dipper on Green River dredge No. 1.

WORK DONE AT CANAL FOR GREEN AND BARREN RIVERS.

The new hull for steamer *Emerald,* commenced in June of last year, was completed July 27. The boat was inspected and necessary alterations and repairs made, and on August 8 the property stored at canal was transferred to the boat and she left for Spottsville, Ky., on the 9th.

Made repairs to cylinders, pistons, pitmen, valve stems, and exhaust pipes for steamer *Wm. Preston Dixon,* and assisted in testing boilers; docked steamer *Wm. Preston Dixon* May 13, and floated her off dock on the 23d; hauled lumber from top of bank to barge, and worked on new rudder stocks.

Very respectfully, your obedient servant,

J. H. Casey,
Assistant Engineer.

Capt. Wm. L. Sibert,
Corps of Engineers, U. S. A.

JJ 3.

IMPROVEMENT OF WABASH RIVER, INDIANA AND ILLINOIS.

The description of original condition, object of the improvements, project, and present condition of work relating to the two divisions of the Wabash River will be found in Annual Reports Chief of Engineers for the fiscal years ending June 30, 1896, page 2239, and June 30, 1898, page 1971.

Improvements below Vincennes.—No work was in progress on this section of the river during the year.

There is in existence no approved project, with estimate, which adequately provides for the systematic improvement of the Wabash River, and, as a prerequisite to the preparation of such a project, a detailed survey is necessary. Such survey for that part of the river below the lock at Grand Rapids would cost, approximately, $20,000. The funds now reported as available were appropriated by the river and harbor act of March 3, 1899, with a view of closing the cut-off at New Harmony, to do which it was estimated would require $50,000. However, this is not the only place where improvement work is needed to make the river navigable, and it would appear to be the better plan to defer any work at New Harmony Cut-off until a survey has been made and definite determination arrived at as to the character and extent of improvements necessary. When such determination is made it may be found that the work now approved for New Harmony Cut-off would be of no particular value as part of a series of structures in a project for systematic improvement of the river. In this connection it is deemed admissible to suggest that, if the funds now available be made applicable to a survey of the river below the lock, only $5,000 in addition thereto will be needed for such purpose.

Money statement.

July 1, 1900, balance unexpended	$15,346.14
July 1, 1901, balance unexpended	15,346.14
July 1, 1901, outstanding liabilities	25.75
July 1, 1901, balance available	15,320.39
Amount (estimated) required for completion of existing project	[1]45,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	[1]45,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

AMOUNTS AND DATES OF APPROPRIATIONS.

June 10, 1872	$50,000	July 5, 1884	$30,000
March 3, 1873	50,000	August 5, 1886	60,000
June 23, 1874	25,000	August 11, 1888	60,000
March 3, 1875	40,000	September 19, 1890	60,000
August 14, 1876	70,000	July 13, 1892	60,000
June 18, 1878	50,000	August 18, 1894	15,000
March 3, 1879	20,000	June 3, 1896	15,000
June 14, 1880	25,000	March 3, 1899	15,000
March 3, 1881	25,000		
August 2, 1882	40,000	Total	710,000

Improvements above Vincennes.—The only operations in progress on this section of the river during the fiscal year was the removal of snags, and embraced that portion between Vincennes and one mile above Hutsonville—about 48 miles. Overhanging trees, snags, and similar obstructions, numbering 375 in all, were removed during the period of operations, from July 17 to September 22, 1900. The work was done by hired plant, consisting of the towboat *Irene* and a barge, the latter with a derrick and appliances equipped for pulling and handling the snags, etc.

Funds under the former estimate are so nearly exhausted that further field work is not proposed for the ensuing fiscal year. Recommendations as to additional appropriations can not be made until a new project, as suggested under "below Vincennes," has been decided upon.

The only commercial statistics available are given in the report for operating and care of lock and dam at Grand Rapids.

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[1] See remarks above concerning survey.

Money statement.

July 1, 1900, balance unexpended	$2,424.33
June 30, 1901, amount expended during fiscal year	1,857.98
July 1, 1901, balance unexpended	566.35

AMOUNTS AND DATES OF APPROPRIATIONS.

March 3, 1881	$25,000	July 13, 1892	$5,000
August 2, 1882	30,000	June 3, 1896	6,000
July 5, 1884	10,000	March 3, 1899	4,000
August 11, 1888	5,000		
September 19, 1890	5,500	Total	95,500

J J 4.

OPERATING AND CARE OF LOCK AND DAM AT GRAND RAPIDS, WABASH RIVER.

* * * * * * *

Operations, in addition to the usual work of passing traffic through the lock, consisted in completing and setting up in place the new wooden lock gates, setting new upper and lower ceramic tile gauges, repairs to the roadways, walks, fences, slopes, removing deposit from the lock chambers and entrances thereto, building a new cottage for the lock tender, and ordinary repairs to other buildings on the lock grounds.

This lock is 2.6 miles above Mount Carmel, Ill., 92.9 miles above the mouth of the Wabash River, and is built of stone. The length of the pool is 9 miles, lift of lock 11.5 feet, available length of lock 214 feet, clear width 52 feet. The lower sill is 372.42 and the upper sill 383.34 feet above mean sea level. The depth of water on the lower sill at low water is 3.5 feet, and on the upper sill 5.08 feet. The top of the lock wall is 398.42 feet above mean sea level and 10 feet above the crest of the dam. The lock was built by the United States, and completed in 1894. Following are the details of expenditures for the fiscal year:

Summary of expenditures on account of operating and care of lock and dam at Grand Rapids, Wabash River, fiscal year 1901, showing general items and amount expended under each heading.

Item.	Amount.
Services	$7,638.17
Supplies	682.29
Materials	2,082.62
Miscellaneous	317.32
Total	10,720.40

ALLOTMENTS.

March 12, 1897	$240.00
July 23, 1897	1,703.25
July 15, 1898	1,451.35
July 21, 1899	9,346.16
July 17, 1900	7,752.52
Total	20,493.28

COMMERCIAL STATISTICS.

Statement of traffic and commerce passed through the lock at Grand Rapids, Wabash River, for the year ending June 30, 1901.

TRAFFIC.

Kind of boat.	Number.	Tonnage.
Tow	49	1,292$\frac{18}{100}$
Barge	68	5,118
House	....	....
Passenger	9	57
Government	4	500
Dredge	6	600
Small craft	106	174
Rafts	25	1,235
Total	267	8,976$\frac{18}{100}$
Passengers	574	....
Lockages	160	....

Commerce.

	Tons.
Corn	673½
Lumber	213
Wheat	102
Miscellaneous	48
Coal	43
Straw	35
Cement	6
Machinery	6
Shingles	2
Total	1,128½

Comparative statement of traffic and commerce passing the lock at Grand Rapids, Wabash River, from July 1, 1896, to June 30, 1901.

TRAFFIC.

Kind of boat.	July 1, 1896, to June 30, 1900.		Fiscal year 1901.		Total for five years.	
	Number.	Tons.	Number.	Tons.	Number.	Tons.
Passenger	16	487	9	57	25	544
Tow	184	5,511	49	1,292	233	6,803
Government	14	445	4	500	18	945
Barges	250	15,537	68	5,118	318	20,655
House	57	295	....	....	57	295
Small craft	488	558	106	174	594	732
Rafts	126	6,600	25	1,235	151	7,835
Total	1,135	29,433	267	8,376	1,396	37,809

Annual average, past five years, 279 boats; 7,561 tons.

Comparative statement of traffic and commerce passing the lock at Grand Rapids, Wabash River, from July 1, 1896, to June 30, 1901—Continued.

COMMERCE.

Articles.	July 1, 1896, to June 30, 1900.	Fiscal year 1901.	Total for five years.
	Tons.	*Tons.*	*Tons.*
Wheat	116	102	218
Corn	6,026	678	6,699
Oats	24	218	237
Lumber	7,881		7,881
Stone	280		280
Hay	10		10
Hogs	18		18
Cord wood	62		62
Coal	86	43	86
Straw		35	
Cement		6	
Machinery		6	
Shingles		2	
Manufactured iron	80		80
Miscellaneous	208	48	208
Total	14,286	1,128	15,224

Annual average past five years, 3,044 tons.

J J 5.

IMPROVEMENT OF WHITE RIVER, INDIANA.

For full report of project, original condition, and works see page 2244, Report of the Chief of Engineers for the fiscal year ending June 30, 1896.

No operations were in progress during the past fiscal year, the funds under the former estimate being almost exhausted.

Pursuant to the requirements of the river and harbor act of August 17, 1894, White River proper and a portion of each, East Fork and West Fork, were resurveyed and full report made, with maps and alternative estimates of the cost of improvement within the limits of the survey. This report and the estimates of cost thereunder will be found on pages 2483 to 2496, Report of the Chief of Engineers for the fiscal year 1896. None of the plans outlined in the report have so far been adopted by Congressional action.

Money statement.

July 1, 1900, balance unexpended	$703.82
July 1, 1901, balance unexpended	703.82

APPROPRIATIONS.

March 3, 1879	$25,000	August 11, 1888	$5,000
June 14, 1880	20,000	July 13, 1892	5,000
March 3, 1881	20,000	August 18, 1894	5,000
August 2, 1882	20,000	June 3, 1896	2,500
July 5, 1884	10,000		
August 5, 1886	7,500	Total	120,000

J J 6.

RECONSTRUCTION OF LOCK NO. 2, GREEN RIVER, AT RUMSEY, KENTUCKY.

Report of project for this work is given on page 2266, Report of the Chief of Engineers, for the fiscal year ending June 30, 1896.

The only work in progress during the year consisted in completing the walk ways and drilling and blasting away the limestone reef at the lower approach to the lock, so as to deepen and straighten it and facilitate the passage of traffic through the lock. This work was entirely completed during the autumn of 1900, and the funds being exhausted, this is the final report of work under the appropriations for this purpose.

Money statement.

July 1, 1900, balance unexpended	$2,260.94
June 30, 1901, amount expended during fiscal year	2,260.94

APPROPRIATIONS.

March 3, 1893	$65,000
August 18, 1894	105,000
Total	170,000

J J 7.

IMPROVEMENT OF GREEN RIVER ABOVE THE MOUTH OF BIG BARREN RIVER, KENTUCKY.

For project, object of improvement, etc., see reports of Chief of Engineers for fiscal years as follows: 1891, pages 2478–2482; 1898, pages 1985–1989.

The amount of funds available during the past fiscal year was too small to permit of work other than the completion of crib work and bank protection at the lock and near the abutment of the dam, and the construction of a cottage for the lock tender.

The marked increase in traffic over this part of the river since the new lock has been in operation is the most substantial evidence of the benefit that has resulted from this part completion of the project which provides for one more lock and dam to carry slack-water navigation to Mammoth Cave. When the second lock, or proposed Lock No. 6, is provided for and completed, water transportation will be available throughout the rich mineral district bordering upon the river, and which heretofore had no conveniently accessible means of marketing its products. Work on the proposed second lock, No. 6, can be commenced promptly after money therefor has been appropriated.

Money statement.

July 1, 1900, balance unexpended	$6,301.93
June 30, 1901, amount expended during fiscal year	1,908.71
July 1, 1901, balance unexpended	4,393.22
July 1, 1901, outstanding liabilities	662.75
July 1, 1901, balance available	3,730.47
Amount (estimated) required for completion of existing project	180,673.20
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	180,673.20
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

AMOUNTS AND DATES OF APPROPRIATIONS.

July 13, 1892	$50,000.00
August 18, 1894	25,000.00
June 3, 1896	20,000.00
March 3, 1899	85,673.20
Total	180,673.20

COMMERCIAL STATISTICS.

Commercial statistics are given in report for operating and care, etc., Green and Barren rivers, Kentucky.

J J 8.

OPERATING AND CARE OF LOCKS AND DAMS ON GREEN AND BARREN RIVERS, KENTUCKY.

The project and estimate for the fiscal year ending June 30, 1901, approved July 17, 1900, and slightly modified September 12, 1900, provided as follows:

"It is proposed to operate the several locks, and to make such repairs to them, the dams and appurtenant structures, as is necessary to maintain the whole system in good, navigable condition, in connection with which work the snagging and dredging outfit, consisting of a snag boat, dredge, derrick boats, and small towboat, will be operated to keep the pools, lock chambers, and entrances thereto free from deposits of mud, snags, and other obstructions brought into them by the varying stages of water. The system now comprises six locks and dams, viz, Nos. 1, 2, 3, 4, and 5, Green River, and No. 1, Barren River; Lock No. 5, Green River, having been completed and opened to navigation in December, 1899. Excepting No. 5, the entire system has heretofore been provided for by allotments from the indefinite appropriation for 'Operating and Care of Canals and Other Works of Navigation,' act of July 5, 1884."

* * * * * * *

During the year the following work was accomplished:

Lock No. 1, Green River.—The bank protection below the abutment of the dam was completed, an area of 6,713 square yards having been riprapped during the year. Additions to both cottages were built and the older portions of the cottages thoroughly repaired; a small warehouse for the storage of supplies and tools was constructed; three of the lock wickets were repaired; the lower river cribs were taken down, rebuilt, and grillage timbers placed between them; the lower end of the island on the river side of the lock was riprapped to prevent cutting away by the reaction of water below the dam; walkways, pavements, and fences were repaired when necessary; one of the gate operating spars was repaired, new gates for fences made and hung; a leak under the lower miter sill of the lock developed March 2, 1901, and its closure effected March 5, 1901, by spiking battens to the floor of the lock chamber; 30 young trees were planted on the lock grounds, the trees on the island trimmed, and the lock grounds cleared of drift, weeds, etc., as often as necessary.

Lock No. 2, Green River.—The slopes were leveled and Bermuda grass set out on same; an addition to one of the cottages at this lock was built; a new flag pole made and set up; the basements of the cottages whitewashed; the upper wickets of the lock cleaned; the older portions of the cottages reshingled and repaired; new coal houses built; fences reset and repaired; new fenders made and placed on lower lock gates; grillage timbers placed between the upper river cribs, and drift, weeds, etc., removed from the lock grounds as often as necessary.

Lock No. 3, Green River.—The upper river approach was renewed; the addition to abutment crib completed; the upper shore crib rebuilt; new top timbers placed on the lower cribs to replace rotten ones; a number of young trees set out; additions to both cottages were built; the sheathing torn off the dam by ice and high water was replaced; the walks were repaired and extended around the new additions to the cottages, and the older parts of the cottages repaired and repainted, and the grounds kept clean of weeds, drift, etc.

Lock No. 4, Green River.—Loam was placed on the slopes where washing had occurred, and an attempt made to secure a set of grass over same; new gauge post was made and painted; an addition built to one of the cottages, and the roofs, porches, and guttering on the older portions of both cottages reshingled and repaired; a new flag pole was made and set up; corner stones, to mark the boundary of land on abutment side of the river, were made and set in place; a much-needed addition to the warehouse at this lock was completed, and all tools and machinery that had been necessarily left poorly protected previously were placed in the warehouse, cleaned, and arranged so as to be convenient for issue and ready for use; a service track for handling heavy machinery, etc., leading from the warehouse to the lock, was built; about 1,500 square yards stone riprap protection was placed on the bank below the abutment; a quantity of new sheeting was placed on the dam, and about 150 cubic yards of stone filling placed in the cribs; repairs were made to the fences, and the grounds kept clean of weeds, drift, etc.

Lock No. 5, Green River.—A new wicket frame to replace a broken one was put in place; the lower miter sill became damaged and was repaired by using 15 long drift bolts and placing about 3 cubic yards of concrete around the bolts and in the cavities which permitted the passage of water; the proposed extension of the row of piles above the dam was abandoned because, after five had been driven, there was evidence that such work disturbed the foundation of the dam; additional piling was driven in front of the outside protection crib on the abutment side, and the height of the crib increased; an additional area of about 1,700 square yards of the bank below the abutment was riprapped (this bank consists almost entirely of sand deposit and would be readily cut away by the reaction of water below the dam if left unprotected); the terrace back of the land wall was leveled up and a number of young trees set out; a number of bowlders was removed from pool No. 5, a few miles below Brownsville; the machinery, tools, etc., stored at this lock, in temporary sheds, were transferred to the warehouse at Lock No. 4, Green River, by the the U. S. snag boat *Wm. Preston Dixon*, after which the sheds were removed to make room for the second cottage to be built at this lock from the appropriation for "Improving Green River, Kentucky."

Lock No. 1, Barren River.—New concrete walks were made; additions were built to both cottages, and the chimneys, roofs, etc., of the older parts of the cottages repaired and painted; hickory turnings were placed on the upper slope of the dam to prevent leakage; the upper river approach was renewed 143 feet long, 9 feet base, 8 feet top width, 11 feet above pool level; the upper shore crib was rebuilt 152 feet long, 9 feet base, 8 feet top width, 11 feet above pool level; the forebay crib was renewed, fences reset and repaired; the pavement back of land wall was taken up, a part of it relaid, and the remaining portion of the area covered with sod.

U. S. snag boat Wm. Preston Dixon.—The operation of this boat extended over all of the pools of Green and Barren rivers, and when not engaged at removing snags and similar obstructions, she assisted in construction work in progress at the several locks, inspection trips, acted as dredge tender, towboat, etc. She was taken to Louisville and placed on the dry dock during April and May, 1901, and her hull overhauled and repaired. A summary of work done by the boat during the fiscal year follows:

As snag boat.	Snags removed.	Stumps removed.	Bowlders removed.	Trees deadened.	Trees removed.	Piles drawn.	Sunken barges removed.	Loaded barges removed.	Crib logs removed.	Miles run.
Location:										
Below Lock No. 1, Green River	20									
Pool No. 1, Green River	185				6			1	28	
Pool No. 2, Green River	189	4		13						
Pool No. 3, Green River	164	1			20					
Pool No. 4, Green River	240			12	152	43	1			
Pool No. 5, Green River	82	2	2	232						
Pool No. 1, Barren River	60									
Total	940	7	2	257	178	43	1	1	28	1,783

	Scows towed.	Material, sand, gravel, etc.	Dredges towed.	Derrick boats towed.	Barges towed.	Quarter boats towed.	Trips made.	Miles run.
		Cu. yds.						
As dredge tender	77	5,115						110
As towboat	29		13	12	23	9		1,150
Miscellaneous							31	1,538
Total	106	5,115	18	12	23	9	31	2,798

Total miles run 4,581.

U. S. towboat Emerald.—A new hull was built for this boat at the Louisville and Portland Canal Dry Dock, and the work of transferring the machinery and cabin thereto completed early in August, 1900, after which date the boat returned to Green River and was utilized for towing purposes at points where such work was necessary until December 22, 1900, when she was laid up for the winter. So far during the present season it has not been necessary to place her in commission. The number of trips made and towing done while she was in commission was as follows:

Trips made, 58; miles run, 2,835. Barges towed, 78; miles run, 2,556.

U. S. dredge No. 1, Green River.—From the beginning of the fiscal year to December 21, the dredge was engaged in removing deposit from the entrances to the locks, assisting in repairs to dams, dredging foundation for protection crib, backing dam at Lock No. 5, Green River, dredging channel at Reedy Island, and in moving disrupted rock from the lower entrance to Lock No. 2, Green River. The quantity of material dredged at each place was as follows:

Location.	Material.	Quantity.
		Cu. yds.
Lock No. 1, Green River	Mud, etc	5,710
Lock No. 2, Green River	Mud and leaves	6,370
Do	Disrupted rock	12,130
Lock No. 4, Green River	Mud, etc	1,850
Lock No. 5, Green River	Mud, sand, etc	3,950
Reedy Island, Green River	Gravel	1,240
Honaker's ferry	do	285
Total		31,535

The only contract in force for this work is that with John P. McGuire, Cleveland, Ohio, for steel lower gates for Locks 1 and 4, Green River, Kentucky, and Lock No. 1, Barren River, Kentucky.

During the fiscal year it became necessary to enlarge the "Regulations for the use, administration, and navigation" of Green and Barren rivers by the addition of rules to be observed by raftsmen. The additional rules having received the approval of the Secretary of War, they were promulgated by the district office in the form of mimeograph copies and dated, as follows:

Additional regulations for the use, administration, and navigation of Green and Barren rivers, Kentucky.

AUTHORITY AND PENALTIES.

The river and harbor act of August 18, 1894, contains the following section:

"SEC. 4. That it shall be the duty of the Secretary of War to prescribe such rules and regulations for the use, administration, and navigation of any or all canals and similar works of navigation that now are, or that hereafter may be, owned, operated, or maintained by the United States as in his judgment the public necessity may require.

Such rules and regulations shall be posted, in conspicuous and appropriate places, for the information of the public; and every person and every corporation which shall knowingly and willfully violate such rules and regulations shall be deemed guilty of a misdemeanor and, on conviction thereof in any district court of the United States within whose territorial jurisdiction such offense may have been committed, shall be punished by a fine not exceeding five hundred dollars, or by imprisonment (in the case of a natural person) not exceeding six months, in the discretion of the court."

RAFTS.

No raft, moored or moving in any of the pools of Green and Barren rivers, Kentucky, shall have a greater width than sixty-four (64) feet, nor a greater length than four hundred and fifty (450) feet. Each raft must have sweep oars at each end, be properly manned, and must be kept under such control as not to seriously interfere with other traffic.

Rafts must not be assembled or moored at such points on the rivers as will seriously interfere with navigation. From sunset to sunrise each day each raft must display lights as follows: On their center line, ten feet above the water, white light on the upstream end; a red light on the downstream end.

United States Engineer Office,
Louisville, Ky., December 31, 1900.

It is made the duty of the master of the U. S. snagboat, *Wm. Preston Dixon* and the lock masters at the several locks in Green and Barren rivers to deliver a copy of these regulations to each interested party, and also to report any and all violations of the regulations published above.

Wm. L. Sibert,
Captain, Corps of Engineers.

On account of the failure of the river and harbor bill and the small quantity of work in prospect during the ensuing year, the continuous services of an assistant engineer were dispensed with and the Bowling Green branch office discontinued May 31, 1901, and the local supervision of routine work placed in charge of Mr. W. S. Overstreet, master and overseer.

Expenditures during the year were as follows:

Summary of expenditures on account of operating and care of Green and Barren rivers, Kentucky, fiscal year 1901, showing general items and amount expended under each heading.

Item.	Amount.
Services	$44,553.68
Supplies	4,572.35
Materials	11,333.35
Miscellaneous	1,357.02
Total	61,816.40

COLLECTIONS.

1900.		
July 6.	Jett & Turner, for water power, Lock No. 2, Green River, Kentucky	$50.00
July 6.	Wm. Boulton, for water power, Lock No. 1, Barren River, Kentucky	75.00
Dec. 7.	Proceeds of auction sale of condemned property	184.10
1901.		
Jan. 12.	Jett & Turner, for water power, Lock No. 2, Green River, Kentucky	50.00
Jan. 12.	R. C. Bryant, for water power, Lock No. 2, Green River, Kentucky	150.00
Jan. 15.	Craig Brothers, for water power, Lock No. 3, Green River Kentucky	37.50
Mar. 15.	Craig Brothers, for water power, Lock No. 3, Green River, Kentucky	37.50
	Total	584.10

All of these collections were deposited to the credit of the Treasurer of the United States.

APPROPRIATIONS AND ALLOTMENTS.

August 11, 1888	$135,000.00	January 26, 1895	$6,000.00
January 4, 1889	167,112.00	July 20, 1895	51,080.31
July 20, 1889	139,110.00	September 2, 1896	77,684.35
July 17, 1890	53,783.47	July 23, 1897	57,459.61
July 16, 1891	77,807.26	July 15, 1898	70,219.75
July 15, 1892	46,264.26	July 22, 1899	67,007.65
July 15, 1893	49,730.88	July 17, 1900	69,349.64
July 13, 1894	25,927.23		

CONTRACT IN FORCE.

For steel lock gates.—"This agreement, entered into this 13th day of April, 1901, between William L. Sibert, captain, Corps of Engineers, United States Army, of the first part, and John P. McGuire, of Cleveland, in the county of Cuyahoga, State of Ohio, of the second part, witnesseth: That, in conformity with the advertisement and specifications hereunto attached, which form a part of this contract, the said William L. Sibert, captain, Corps of Engineers, U. S. Army, for and in behalf of the United States of America, and the said John P. McGuire, do covenant and agree, to and with each other, as follows:

That the said John P. McGuire shall furnish and deliver three pairs of lock gates and all fittings therefor, as specified and required in the specifications hereto attached, and the drawings therefor described in paragraph 36 of said specifications.

That for the said gates and their fittings furnished and delivered in accordance with said specifications and drawings, the United States shall pay the said John P. McGuire as follows:

For the pair of gates for Lock No. 1, Green River, Kentucky, three thousand dollars ($3,000.00).

For the pair of gates for Lock No. 4, Green River, Kentucky, three thousand dollars ($3,000.00).

For the pair of gates for Lock No. 1, Barren River, Kentucky, two thousand eight hundred dollars ($2,800.00).

* * * * * * *

The said John P. McGuire shall commence the work herein contracted for within ten (10) days after the date of notification of approval of the contract by the Chief of Engineers, U. S. Army, and shall complete the same on or before November 30, 1901."

Approved by the Chief of Engineers, United States Army, April 25, 1901.

COMMERCIAL STATISTICS.

Statements of traffic passing the locks on Green and Barren rivers from July 1, 1897, to June 30, 1901.

LOCK NO. 1, GREEN RIVER.

Kind of craft.	Fiscal years 1898 to 1900.		Fiscal year 1901.	
	Number.	*Tonnage.*	*Number.*	*Tonnage.*
Passenger boats	1,535	240,795	548	93,072
Towboats	1,349	110,683	812	55,052
Government boats	60	9,217	30	3,801
Barges	2,924	475,227	1,765	405,602
Small craft	441	5,543	109	1,103
Rafts	1,891	....	592	....
Total	8,200	841,775	3,856	558,630

Annual average during past four years: Boats, 3,014; tonnage, 350,126+.
Total number of lockages during past fiscal year, 4,396.

LOCK NO. 2, GREEN RIVER.

Kind of craft.	Fiscal years 1898 to 1900.		Fiscal year 1901.	
	Number.	*Tonnage.*	*Number.*	*Tonnage.*
Passenger boats	1,541	242,577	582	91,587
Towboats	1,390	70,960	638	42,286
Government boats	116	18,884	34	4,787
Barges	2,753	467,193	1,443	343,782
Small craft	406	5,330	103	670
Rafts	1,250	....	302	....
Total	7,456	804,944	3,102	483,112

Annual average during past four years: Boats, 2,639+; tonnage, 322,014.
Total number of lockages during past fiscal year, 3,626.

Statements of traffic passing the locks on Green and Barren rivers, etc.—Continued.

LOCK NO. 3, GREEN RIVER.

Kind of craft.	Fiscal years 1898 to 1900.		Fiscal year 1901.	
	Number.	*Tonnage.*	*Number.*	*Tonnage.*
Passenger boats	1,323	223,024	561	91,689
Towboats	974	66,588	455	33,266
Government boats	138	23,535	37	5,090
Barges	1,840	333,104	1,081	284,115
Small craft	407	1,932	71	257
Rafts	736		202	
Total	5,418	648,183	2,410	414,417

Annual average during past 4 years: Boats, 1,957; tonnage, 265,260.
Total number of lockages during past fiscal year, 2,689.

LOCK NO. 4, GREEN RIVER.

Kind of craft.	Fiscal years 1898 to 1900.		Fiscal year 1901.	
	Number.	*Tonnage.*	*Number.*	*Tonnage.*
Passenger boats	1,195	210,740	563	91,580
Towboats	2,169	106,092	784	40,922
Government boats	196	34,623	70	10,724
Barges	2,641	358,570	1,017	227,495
Small craft	407	1,932	71	124
Rafts	736		75	
Total	6,780	711,669	2,580	370,845

Annual average during past 4 years: Boats, 2,340+; tonnage, 270,628+.
Total number of lockages during past fiscal year, 2,658.

LOCK NO. 5, GREEN RIVER.

Kind of craft.	Fiscal year 1900.		Fiscal year 1901.	
	Number.	*Tonnage.*	*Number.*	*Tonnage.*
Passenger boats	32	4,011		
Towboats	206	11,378	376	20,270
Government boats	14	1,222	52	6,756
Barges	255	34,945	383	97,141
Small craft	62	144	165	749
Rafts	47		29	
Total	616	51,695	1,005	124,916

Opened to traffic January 17, 1900.
Annual average during past 2 years: Boats, 810 +; tonnage, 88,305 +.
Total number of lockages during past fiscal year, 1,070.

LOCK NO. 1, BARREN RIVER.

Kind of craft.	Fiscal years 1898 to 1900.		Fiscal year 1901.	
	Number.	*Tonnage.*	*Number.*	*Tonnage.*
Passenger boats	994	182,487	564	91,012
Tow boats	1,418	56,197	428	19,125
Government boats	155	23,366	70	8,899
Barges	1,513	155,876	497	75,994
Small craft	153	696	28	17
Rafts	8		20	
Total	4,291	418,622	1,612	195,047

Annual average during past 4 years: Boats, 1,475 +; tonnage, 613,669.
Total number of lockages during past fiscal year, 1,667.

Statements of commerce passing the locks on Green and Barren Rivers, July 1, 1897, to June 30, 1901.

LOCK NO. 1, GREEN RIVER.

Articles.	Fiscal years 1898 to 1900.	Fiscal year 1901.	Articles.	Fiscal years 1898 to 1900.	Fiscal year 1901.
	Tons.	*Tons.*		*Tons.*	*Tons.*
Coal	2,161	1,365	Swine and sheep	3,078	1,248
Corn	2,629	2,135	Horses and mules	827	77
Wheat	2,244	952	Lumber	66,485	25,233
Salt	3,287	1,040	Timber	432,185	254,314
Oil	1,088	194	Staves	17,968	5,533
Whisky	87	33	Shingles	144	99
Flour	1,844	754	Ties, railroad	194,189	130,304
Sugar	1,978	803	Hoop poles	3,404	1,840
Molasses	598	245	Manufactured iron	407	50
Cement	1,933	181	Produce	46	10
Tobacco	2,675	906	Asphalt	....	445
Hides	28	5	General and miscellaneous	86,202	22,223
Hay and straw	2,074	1,373			
Cattle	2,766	1,160	Total	829,273	452,522

LOCK NO. 2, GREEN RIVER.

Articles.	Fiscal years 1898 to 1900.	Fiscal year 1901.	Articles.	Fiscal years 1898 to 1900.	Fiscal year 1901.
Coal	1,854	326	Swine and sheep	1,290	640
Corn	1,482	1,893	Horses and mules	306	61
Wheat	907	264	Lumber	34,468	12,445
Salt	3,056	684	Timber	282,479	128,697
Oil	933	184	Staves	20,909	5,182
Whisky	92	26	Shingles	94	50
Flour	1,511	542	Ties, railroad	199,579	111,678
Sugar	1,675	625	Hoop poles	2,036	1,258
Molasses	396	194	Manufactured iron	1,150	51
Cement	1,199	152	Produce	23	8
Handles	1,871	4	Asphalt	....	995
Tobacco	2,314	674	General and miscellaneous	58,471	17,799
Hides	19	8			
Hay and straw	1,818	911	Total	617,003	285,744
Cattle	1,121	393			

LOCK NO. 3, GREEN RIVER.

Articles.	Fiscal years 1898 to 1900.	Fiscal year 1901.	Articles.	Fiscal years 1898 to 1900.	Fiscal year 1901.
Coal	702	928	Swine and sheep	1,880	888
Corn	663	496	Horses and mules	180	108
Wheat	271	90	Lumber	10,296	3,534
Salt	1,926	584	Timber	152,802	78,489
Oil	561	249	Staves	11,581	509
Whisky	38	10	Shingles	45	81
Flour	1,086	333	Ties, railroad	132,568	82,883
Sugar	1,086	479	Hoop poles	1,879	677
Molasses	284	89	Manufactured iron	218	81
Cement	1,982	122	Produce	11	6
Handles	1,102	....	Asphalt	....	780
Tobacco	578	319	General and miscellaneous	42,415	11,585
Hides	22	3			
Hay and straw	1,284	607	Total	365,257	183,512
Cattle	797	282			

LOCK NO. 4, GREEN RIVER.

Articles.	Fiscal years 1898 to 1900.	Fiscal year 1901.	Articles.	Fiscal years 1898 to 1900.	Fiscal year 1901.
Coal	61,546	3,187	Swine and sheep	330	105
Corn	436	437	Horses and mules	149	146
Wheat	150	7	Lumber	14,644	3,027
Salt	1,236	449	Timber	46,033	27,080
Oil	308	124	Staves	5,830	1,075
Whisky	55	28	Shingles	1,959	39
Flour	1,460	379	Ties, railroad	97,031	70,274
Sugar	1,019	338	Hoop poles	348	49
Molasses	180	98	Manufactured iron	124	9
Cement	1,924	....	Produce	7	2
Handles	1,589	243	Asphalt	....	730
Tobacco	330	162	General and miscellaneous	30,322	8,512
Hides	116	5			
Hay and straw	721	485	Total	267,949	117,054
Cattle	157	64			

Statements of commerce passing the locks on Green and Barren rivers, etc.—Continued.

LOCK NO. 5, GREEN RIVER.

Articles.	Fiscal year 1900.	Fiscal year 1901.	Articles.	Fiscal year 1900.	Fiscal year 1901.
	Tons.	*Tons.*		*Tons.*	*Tons.*
Coal	296	174	Lumber	4	692
Corn	98	99	Timber	22,049	11,818
Salt	33	162	Staves	228	140
Oil	18	26	Shingles	1	....
Flour	90	57	Ties, railroad	23,724	43,468
Sugar	30	82	Hoop poles	3	106
Molasses	15	8	General and miscellaneous	420	648
Cement	6	7			
Hay and straw	82	121	Total	47,098	57,058
Horses and mules	1	....			

LOCK NO. 1, BARREN RIVER, KENTUCKY.

Coal	61,057	15,708	Swine and sheep	181	26
Corn	387	49	Horses and mules	145	109
Wheat	42	13	Lumber	3,468	1,257
Salt	946	177	Timber	7,799	15,499
Oil	181	88	Staves	644	298
Whisky	30	9	Shingles	1,927	25
Flour	1,474	427	Ties, railroad	3,250	1,848
Sugar	647	250	Hoop poles	119	26
Molasses	97	87	Manufactured iron	56	43
Cement	146	44	Produce	4	5
Handles	2,162	246	Asphalt	....	3,226
Tobacco	262	178	General and miscellaneous	18,920	6,760
Hides	....	3			
Hay and straw	547	3	Total	104,582	46,445
Cattle	101	41			

In addition to the foregoing, there was mined and shipped from the "Rankin Mines," at Spottsville, Ky., below Lock No. 1, Green River, 1,210,543 bushels of coal, equal to 48,421 tons.

J J 9.

IMPROVEMENT OF ROUGH RIVER, KENTUCKY.

For original condition, object of improvement, and project, see Report of the Chief of Engineers for fiscal year ending June 30, 1899, page 2599.

The work outlined in the project has been completed with the exception of snagging, which class of work must be done from time to time as long as the source of snags is in existence. Operations during the year consisted of the removal of two slides below Hartford; removing overhanging trees, snags, stumps, etc.; in building a protection crib 45 feet long, 10 feet wide, and 6 feet high below the abutment of the dam at the lock; and grading and riprapping the banks below the abutment and lock.

A summary of the work accomplished is as follows:

Overhanging trees removed		87
Snags removed		50
Stumps removed		8
"Floaters" (water-soaked logs) removed		40
Earth slides removed	cubic yards	2,200
Mud removed from upper entrance to lock	do	280
Material dredged from foundation for protection crib	do	560
Stone placed in crib	do	138
Area covered with riprap	square yards	700
Earth moved in grading banks	cubic yards	260

The funds available are sufficient to keep the improved portion of the river clear of snags during the next fiscal year.

No contracts for this improvement are in force.

For commercial statistics, see report for operating and care of lock and dam, Rough River, Kentucky.

Money statement.

July 1, 1900, balance unexpended	$6,082.97
June 30, 1901, amount expended during fiscal year	2,887.78
July 1, 1901, balance unexpended	3,195.19
July 1, 1901, outstanding liabilities	17.27
July 1, 1901, balance available	3,177.92

APPROPRIATIONS.

September 19, 1890	$25,000
July 13, 1892	15,000
August 18, 1894	22,500
June 3, 1896	43,000
Total	105,500

J J 10.

OPERATING AND CARE OF LOCK AND DAM ON ROUGH RIVER, KENTUCKY.

This lock and dam were built from funds provided in appropriations for improving Rough River, Kentucky, and were opened to navigation December 12, 1896. The estimate and project for the operation and care of the lock and appropriations during the fiscal year ending June 30, 1901, contained items as follows:

Regular force	$750
Repairs, supplies, etc	500
	1,250

Expenditures during the year were for payment of salary of lock tender, messenger service between the lock and nearest post-office, incidental repairs, and expenses.

Summary of expenditures on account of operating and care of Rough River, Kentucky, fiscal year 1901, showing general items and amount expended under each heading.

Item.	Amount.
Services	$744.86
Materials	7.50
Total	752.36

ALLOTMENTS.

July 23, 1897	$2,086.00
July 9, 1898	1,173.92
July 22, 1899	714.97
July 17, 1900	686.31
Total	4,661.20

COMMERCIAL STATISTICS.

Statement of traffic and commerce through Lock No. 1, Rough River, Kentucky.

TRAFFIC.

Kind of craft.	July 1, 1897, to June 30,1900.		Fiscal year 1901.	
	Number.	Tonnage.	Number.	Tonnage.
Passenger boats	152	11,905.14	....	....
Towboats	358	5,829.25	175	2,052
Government boats	4	277	5	341
Barges	171	14,006.80	114	21,769
Small craft	450	1,170.47	242	245
Rafts	655	....	121	....
Total	1,785	32,688.16	657	24,407

Annual average during past four years: Boats, 610; tonnage, 14,278.79.
Total number of lockages during past fiscal year, 920.

COMMERCE.

Articles.	July 1, 1897, to June 30, 1900.	Fiscal year 1901.	Articles.	July 1, 1897, to June 30, 1900.	Fiscal year 1901.
	Tons.	*Tons.*		*Tons.*	*Tons.*
Coal	259	....	Cattle	13	....
Corn	18	....	Swine and sheep	10	....
Wheat	8	....	Horses and mules	4	....
Salt	247	....	Lumber	1,507	258
Oil	76	....	Timber	61,064	19,092
Whisky	11	....	Staves	4,332	....
Flour	112	....	Shingles	14	....
Sugar	54	....	Ties, railroad	8,696	1,336
Molasses	28	....	Manufactured iron	67	....
Cement	51	....	Miscellaneous	1,592	....
Handles	16	....			
Tobacco	20	....	Total	78,780	20,666
Hay	41	....			

J J II.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

The steamboat *Defender*, while taking a tow of coal through the canal January 20, 1901, sunk a loaded barge at station 25. The accident was apparently due to carelessness on the part of the crew in not keeping the leakage water pumped out of the barge. The wreck was owned by the Monongahela River Consolidated Coal and Coke Company, and, they not having facilities for removing it promptly, it was arranged for the canal dredges to remove the wreck, placing the coal in a barge furnished by the company. The amount of the expense for removing the wreck, $99.39, was collected from the company and deposited to the credit of the Treasurer of the United States and disbursement of the same amount of funds from the appropriation for "Removal of Sunken Vessels or Craft, etc.," made.

J J 12.

PRELIMINARY EXAMINATION, OHIO RIVER (IN KENTUCKY), WITH A VIEW TO ASCERTAINING THE DESIRABILITY OF ACQUIRING THE ISLAND IMMEDIATELY BELOW THE LOUISVILLE AND PORTLAND CANAL IN THE OHIO RIVER, KNOWN AS SAND ISLAND, AND PROBABLE COST OF PURCHASING THE SAME.

[Printed in House Doc. No. 68, Fifty-sixth Congress, second session.]

Office of the Chief of Engineers,
United States Army,
Washington, November 21, 1900.

Sir: I have the honor to submit herewith for transmission to Congress copy of report dated June 20, 1900, by Capt. George A. Zinn, Corps of Engineers, upon preliminary examination authorized by the emergency river and harbor act approved June 6, 1900.

With a view to ascertaining the desirability of acquiring the island immediately below the Louisville and Portland Canal in the Ohio River, known as Sand Island, and probable cost of purchasing the same.

Very respectfully, your obedient servant,

John M. Wilson,
Brig. Gen., Chief of Engineers,
U. S. Army.

Hon. Elihu Root,
Secretary of War.

REPORT OF CAPT. GEO. A. ZINN, CORPS OF ENGINEERS.

United States Engineer Office,
Louisville, Ky., June 20, 1900.

General: I have the honor to make the following report upon a preliminary examination of "Ohio River (in Kentucky), with a view to ascertaining the desirability of acquiring the island immediately below the Louisville and Portland Canal in the Ohio River, known as Sand Island, and probable cost of purchasing the same," in accordance with instructions contained in letter from Office of the Chief of Engineers, United States Army, dated Washington, D. C., June 13, 1900.

As the information necessary for a report in this matter was already on file in this office, no further examination of the locality was required and consequently no additional expense accrued.

Sand Island, as shown on the accompanying drawing,[1] lies in the middle of the Ohio River, opposite the lower entrances to the old and new locks, and just above the Kentucky and Indiana railway bridge. At low stages of water its greatest length is about 5,400 feet, greatest breadth about 1,600 feet, and area about 74 acres. At medium stages the corresponding figures are: Length, 3,650 feet; width, 1,000 feet;

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[1] Not printed.

area, 33 acres. At high stages of the river the island is entirely overflowed, and this occurs practically every year.

William F. Nugent, the representative of the legal owner, Katherine E. Nugent, informs me, upon my request, that the island was purchased, with a clear title, in 1896 for $3,000; that he obtains a rent of $150 per year for fishing privileges and $75 per year for farming privilege. He also obtains a fee of $15 from each towboat for the privilege of tying up at the island for the purpose of making up tows of loaded boats going south. He could not estimate the average number of such tows, but believed it to be in the vicinity of 100 each year. He has never considered the proposition to dispose of the entire island and has not previously been approached on the subject. He thinks, however, that the sum of $25,000 would be accepted. At the present time he makes no other use of the island than that above stated. He purchased the island primarily to obtain sand from it, as his business is the sale of sand for all purposes, and expects at some future time to obtain sand there for his business.

I can find no record in this office of any recommendation or proposition ever having been made by any officer or employee of the Engineer Department for the purchase by the United States of this island, nor any official expression on the part of such persons of the desirability of purchasing it for any use whatsoever, nor any recommendation from any person interested in the navigation of the Ohio River for its purchase.

The project for improving the Falls of the Ohio River at Louisville, Ky., does not include the use of this island, nor require its use. While its presence is unobjectionable, its absence would be equally so; certainly no proposition would ever be made in connection with the project mentioned, either for its removal or retention. The low-water channel of the river is on the south side of the island and the high-water channel on the north side, the bed of the river throughout being solid rock. In the natural condition of the river a deposit of sediment was made during high water along the lower entrances to the old and new locks. In order to prevent this deposit or to remove it during low stages of the river, a dam was built in 1871 and 1872 connecting the head of the island with the Indiana shore, thus throwing the entire discharge of the river at low stages into the southern channel. The maintenance of this dam is deemed essential at the present time, but depends in no wise upon the existence of the island, for were it entirely removed the dam could and would be maintained with equal ease. In other words, so far as the improvement of navigable channels is concerned, the island is of no use to the United States.

With respect to the methods employed in navigating the improved channels above referred to, Sand Island holds an entirely different relationship toward the interests of navigation, as the following description will show. The regulations governing the navigation of the Louisville and Portland Canal limit the size of single tows passing through the canal to (1) 12 coal boats and 4 fuel boats; (2) 10 model barges and 4 fuel boats; (3) 20 square barges. The tows must be strung out two wide for passage. The capacity of the locks is such as to permit of the passage at one time of from two to four boats or barges. As the parts of a tow are thus discharged from the lower entrance to the locks they are taken by a steamboat to a suitable place until all are collected, when they are re-formed for a continuation of their southern journey, in a tow varying in width from two to eight pieces. This rearrangement of the tow is made by attaching the bow and side lines of the first lockage to an anchorage on shore and adding the remaining parts successively as they are brought from the locks. Now, it happens that the most suitable, but not the only, place for thus making up tows is at the foot of Sand Island, the lines being attached to anchorages on shore at low stages, and to the piers of the Kentucky and Indiana Railroad bridge at higher stages.

As stated above, the owner of Sand Island charges each tow the sum of $15 for this privilege. The yearly number of tows made up at Sand Island varies, but the records of the canal office show that about thirty tows were made up there during the past year. It may be remarked that tows passing over the falls also go down in parts, which are reassembled at West Louisville or some other point below Sand Island where no fee is charged.

The tows referred to above are composed almost entirely of coal boats and barges which require, at the present time, a stage of 12 feet of water on the canal gauge in order to pass safely over the falls; at stages less than 12 feet and down to 8 feet, they pass through the canal. Navigation of this class ceases at 8 feet. It is expected that when the present project for the improvement of the falls is completed, tows can pass over the falls at a stage of 10 feet. If this expectation is realized, the number of tows passing through the canal, and consequently of those using Sand Island, will be very materially reduced; exactly how much can not be foretold nor calculated, because the conditions affecting it are so numerous and diverse.

In conclusion, I have the honor to state that, after a careful consideration of the facts related above, I am not of the opinion that it is desirable to purchase Sand Island, as it bears no relation to any project of improvement now in force or contemplated in connection with the work under charge of this office. From Mr. Nugent's statement it will be observed that the probable cost of purchasing this island would be about $25,000.

Very respectfully, your obedient servant,

GEO. A. ZINN,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[Third indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION,
New York, July 6, 1900.

Respectfully returned to the Chief of Engineers, United States Army.

I concur with Captain Zinn in the opinion that it is not desirable to purchase Sand Island, as it bears no relation to any project of improvement now in force or contemplated.

HENRY M. ROBERT,
Colonel, Corps of Engineers,
Division Engineer.

[Fourth indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
October 25, 1900.

Respectfully submitted to the Secretary of War, concurring in the opinion of the local officer and of the division engineer that improvement of the locality by the General Government in the manner indicated by the act authorizing the examination is not advisable.

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

[Fifth indorsement.]

WAR DEPARTMENT, *October 27, 1900.*

The views of the local officer and of the division engineer, as concurred in by the Chief of Engineers, are approved.

ELIHU ROOT,
Secretary of War.

APPENDIX K K.

IMPROVEMENT OF RIVERS AND HARBORS ON LAKE SUPERIOR.

REPORT OF CAPT. D. D. GAILLARD, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1901, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Harbor at Grand Marais, Minnesota.
2. Harbor at Agate Bay, Minnesota.
3. Harbor at Duluth, Minnesota, and Superior, Wisconsin.
4. Harbor at Ashland, Wisconsin.
5. Harbor at Ontonagon, Michigan.
6. Waterway from Keweenaw Bay to Lake Superior, Michigan.
7. Harbor at Marquette, Michigan.
8. Harbor of refuge, Marquette Bay, Michigan.
9. Harbor of refuge at Grand Marais, Michigan.
10. Removing sunken vessels or craft obstructing or endangering navigation.

SPECIAL REPORT.

11. Notes on rock found in vicinity of Duluth, Minnesota.

EXAMINATION AND SURVEY.

12. Burlington Bay, Minnesota.

UNITED STATES ENGINEER OFFICE,
Duluth, Minn., July 13, 1901.

GENERAL: In compliance with General Orders, No. 1, Headquarters Corps of Engineers, United States Army, Washington, D. C., April 20, 1901, I have the honor to transmit herewith my annual report * * * of the works under my charge.

Very respectfully,

D. D. GAILLARD,
Captain, Corps of Engineers.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

K K 1.

IMPROVEMENT OF HARBOR AT GRAND MARAIS, MINNESOTA.

This harbor is an elliptical bay, whose major axis is about one-half mile and whose minor axis is about one-fourth of a mile in length. It has an opening on the south side which was originally about 1,000 feet in width. Before improvement there was a maximum depth of 14 feet over a very limited area, the general average depth being only 8 or 9 feet. It is the only harbor of refuge on the north shore between Agate Bay and the international boundary line.

The approved project of 1879 is to build two breakwater piers, each 350 feet long, from the east and west points of the bay, or one pier 700 feet long from the east point, and dredge an anchorage area of about 26 acres to a depth of at least 16 feet, all at an estimated cost of $139,669.40. The object of this work is to provide a harbor for purposes of refuge and commerce, which it has fully accomplished as far as completed.

The improvement of the harbor was commenced in 1880.

Previous to June 30, 1900, the east breakwater pier had been finished to a length of 350 feet, and the dredging of the 16-foot anchorage area of 26 acres entirely completed.

This anchorage gives room for safe swinging at anchor of a few vessels only, and with the development of shipping should be increased to the full capacity of the harbor, which has an area of about 61 acres.

The work of improvement has been carried on by contract after due advertisement. The total amount dredged to date has been 337,948 cubic yards, at an actual cost of $81,463.50, or a trifle more than 24 cents a cubic yard as an average.

The 350 feet of pier has cost $31,147 for construction and $3,238.44 for repairs. These figures do not include expenses of surveys, administration, and inspection, which have been nearly 15 per cent, owing to the distance of this harbor from the market for labor and material and its isolated situation in general.

The act of March 3, 1899, appropriated $30,000 to complete the entire project, and with this it is proposed to construct 350 feet of breakwater from the westerly point, running in a southeasterly direction, consisting of a timber crib and superstructure on a stone embankment brought up to the —20-foot level.

After due advertisement the contract for this work was let to the Butler-Ryan Company, of St. Paul, Minn., the lowest bidders.

Work was commenced May 24, 1900, and carried on until the close of the working season, when 211 linear feet of embankment, 150 linear feet of cribs, and 125 linear feet of superstructure had been completed. A severe storm on November 3, 1900, dislodged and damaged a 100-foot crib, which had been partially filled with rock. The contract expired December 1, 1900, but work was resumed by the contractors this spring at the same prices, under an implied agreement authorized by the Chief of Engineers, United States Army, and on June 30, 1901, a total of 220 linear feet of embankment, 350 linear feet of cribs, and 125 linear feet of superstructure had been completed, all of which was placed during the past fiscal year.

With the construction of this breakwater the approved project will be completed.

Owing to the fact that the west pier projects so much farther south than the east pier, it seems quite possible that during the prevalence of severe northeast storms vessels will have more difficulty than heretofore in rounding the east pier and keeping out of the shoal water, which comes within about 450 feet of the outer end of this pier.

Should this difficulty arise, and should the increase in commerce justify the expenditure, it could be partially obviated by further dredging to the westward of the east pier, and entirely obviated by building a new east pier about 350 feet long in prolongation of the rocky reef, and making an angle of about 45 degrees with the present east pier.

Rich mineral deposits are alleged to exist in the back country. Should these be opened up and connected with the lake by railroad, the harbor may become of importance for the shipment of ore.

The first commercial report, that of 1878, showed that 4 tugs and 5 schooners entered and departed from this harbor, making 25 arrivals and clearances in all, and doing a business of 60 tons, valued at $6,000. In 1899 the total arrivals and clearances were 346 vessels, principally steamers, with a total cargo tonnage of 6,203 tons, valued at $454,360.

The records for 1900 were all destroyed by fire in January, 1901. (See letter of Mr. H. Mayhew, which follows.)

This work is in the collection district of Duluth, Minn. Duluth, Minn., is the nearest port of entry. The nearest light-house is situated on the breakwater at Grand Marais.

Money statement.

July 1, 1900, balance unexpended	$30,249.34
June 30, 1901, amount expended during fiscal year	9,312.26
July 1, 1901, balance unexpended	20,937.08
July 1, 1901, outstanding liabilities	902.18
July 1, 1901, balance available	20,034.90
July 1, 1901, amount covered by uncompleted contracts	19,978.26
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement, in addition to the balance unexpended July 1, 1901 Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	2,000.00

Abstract of appropriations for improving harbor at Grand Marais, Minn.

By act of Congress—		By act of Congress—	
Approved March 1, 1879	$10,000	Approved Sept. 19, 1890	$22,350
Approved June 14, 1880	10,000	Approved July 13, 1892	10,000
Approved March 3, 1881	20,000	Of August 18, 1894	3,000
Passed August 2, 1882	20,000	June 3, 1896	3,000
Approved July 5, 1884	10,000	March 3, 1899	30,000
Approved August 5, 1886	10,000		
Passed August 11, 1888	15,000	Total	163,350

COMMERCIAL STATISTICS.

Freight received and shipped for eighteen years.

Year.	Tons.	Value.	Year.	Tons.	Value.
1882	224	$25,691	1892	756	$65,374
1883	239	27,595	1893	907	78,460
1884	270	30,198	1894	441	41,230
1885	390	41,484	1895	913	91,300
1886	475	48,519	1896	1,360	114,198
1887	312	29,059	1897	1,777	122,868
1888	460	44,871	1898	3,182	249,764
1889	252	29,349	1899	6,203	454,360
1890	275	32,035	1900	....	....
1891	319	32,687			

No new lines of transportation were established.

Arrivals and clearances of vessels for eighteen years.

Year.	Arrivals.	Clearances.	Year.	Arrivals.	Clearances.
1882	134	134	1892	146	145
1883	131	131	1893	133	133
1884	152	158	1894	219	221
1885	188	190	1895	186	181
1886	210	210	1896	202	200
1887	164	164	1897	185	186
1888	190	190	1898	145	146
1889	168	168	1899	186	160
1890	268	268	1900	....	....
1891	160	159			

LETTER FROM MR. H. MAYHEW.

GRAND MARAIS, MINN., *April 15, 1901.*

SIR: In reply to your request to furnish a statement of the commercial statistics of the port of Grand Marais, Minn., for the calendar year 1900, I have the honor to state that I am unable to furnish the statistics in consequence of all of our records having been destroyed by fire, the night of January 16 last.

This we regret, as we would have been able to make a good and satisfactory exhibit for the year. The arrival and departure of steam vessels was twofold in excess of any former years.

The great number of vessels coming in the harbor for shelter was evidence of the importance of the value of the harbor in that respect.

Very respectfully,

H. MAYHEW.

D. D. GAILLARD,
Captain of Engineers, U. S. A.

K K 2.

IMPROVEMENT OF HARBOR AT AGATE BAY, MINNESOTA.

Agate Bay, on which is situated the town of Two Harbors, Minn., is a semicircular harbor of 2,000 feet radius. There is a good navigable depth throughout the greater part of the harbor, but it is exposed to storms from the southwest and from reverse swells of hard storms from the northeast.

The natural shelter it afforded caused the erection of three extensive ore docks by the Duluth and Iron Range Railroad; a commercial dock, and a dock for landing coal.

The rapid increase in the commerce of the harbor caused Congress to undertake its improvement by an appropriation of $22,500 in August, 1886.

The approved project of 1887 was to construct two breakwater piers on a line toward each other from the eastern and western points of the bay to be 1,000 and 900 feet long, respectively, leaving an opening of 1,340 feet between their extremities and inclosing an area of 109 acres.

By letter of the Chief of Engineers, March 23, 1899, the total ultimate length of the easterly breakwater was increased by 50 feet.

The original estimate of cost was $213,000, which was increased to $244,208 in annual report of 1887 on account of higher prices.

The object is to protect shipping at the wharves, which otherwise would be greatly exposed. Work was commenced in 1887 on the east pier, which was completed to a length of 750 feet.

The amount expended on this project up to the close of the fiscal year ending June 30, 1900, was $180,724.93. At that date the work done had greatly aided commerce by giving protection to the docks.

The act of March 3, 1899, appropriated $71,708 to complete the project for the improvement of this harbor. With this sum during the fiscal year ending June 30, 1901, the west pier was completed to its full length of 900 feet, under contract with Powell & Mitchell, of Marquette, Mich.

At the east pier 183 feet of rock embankment was built, under contract with Engle & Osman, of Duluth, Minn., completing the embankment for this pier.

Work is still in progress upon the crib and superstructure extension of the east pier, under contract with Powell & Mitchell, of Marquette, Mich. This extension is to have a total length of 300 feet, and is to run out to the southwest at an angle of 45 degrees with the old work, thus giving a greater protection to the ore docks, and leaving the space between the ends of the breakwaters in better shape for the entrance and exit of vessels.

To June 30, 1901, 4 cribs, aggregating 200 feet in length, had been sunk, leaving 2 cribs yet to be placed.

It is expected that the work will be entirely completed by September 1, 1901.

Whatever balance may be left over will be expended in the repair of the old portion of the superstructure of the east pier.

With the finishing of this work the project for the improvement of this harbor will be completed.

Between midnight, June 21, and 1 a. m. June 22, 1901, the wooden steamer *Volunteer*, of the Gilchrist Steamship Line, Capt. Wilson McGregor, master, struck with her bow the superstructure of the east breakwater at a point near the outer end of the old structure, breaking and displacing a number of timbers. The estimated cost of repairs is $75 to $100. Immediately upon receiving the report of the United States assistant engineer a letter was addressed to the manager of the Gilchrist Steamship Line, at Cleveland, Ohio, requesting to be informed whether he intended to repair the damage himself, to the satisfaction of this office, or preferred to have the repairs made by this office and a bill for the cost of same sent to the United States district attorney for collection. No reply has yet been received.

The Duluth and Iron Range Railroad has now in successful operation five large ore docks which, with their coal and commercial docks, utilize most of the available room in the harbor, leaving comparatively little available anchorage ground.

The Duluth and Iron Range Railroad Company is reputed to be now the sole riparian owner of the entire shore lying inside of the United States breakwater piers, but such was not the case when operations for the improvement of this harbor were commenced by the United States.

Of iron ore there was shipped from this port during the season of 1900, 4,014,375 gross tons.

The total amount expended on this harbor from 1886 to June 30, 1901, has been $215,013.90. The annual cargo tonnage has increased from 236,000 tons, valued at $524,800 in 1885, to $4,723,784 net tons, valued at $11,066,026, in 1900. The total valuation of the cargo tonnage into and out of this port in the sixteen years ending December 31, 1900, is roughly estimated at $51,000,000.

Agate Bay, known locally as Two Harbors, is in the collection district of Duluth, Minn. which is also the nearest port of entry. The nearest light-house is situated on the east point, Agate Bay, Minnesota.

Money statement.

July 1, 1900, balance unexpended	$63,483.07
June 30, 1901, amount expended during fiscal year	34,288.97
July 1, 1901, balance unexpended	29,194.10
July 1, 1901, outstanding liabilities	4,415.14
July 1, 1901, balance available	24,778.96
July 1, 1901, amount covered by uncompleted contracts	18,668.49
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement, in addition to the balance unexpended July 1, 1901 Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	2,000.00

Abstract of appropriations for improving harbor at Agate Bay, Minnesota.

By act of Congress—		By act of Congress—	
Approved August 5, 1886	$22,500	Of August 18, 1894	$30,000
Passed August 11, 1888	15,000	Passed June 3, 1896	50,000
Approved September 19, 1890	25,000	Approved March 3, 1899	71,708
Approved July 13, 1892	30,000	Total	244,208

LIST OF EXISTING CONTRACTS.

Contract with Powell & Mitchell, of Marquette, Mich., for building pier extentions in harbor at Agate Bay, Minnesota, dated March 15, 1900, approved April 10, 1900, work to commence May 15, 1900, and be completed September 1, 1901:

Cribs 18½ by 24 feet	per linear foot	$55.30
Cribs 18½ by 30 feet	do	67.55
Superstructure 6 by 24 feet	do	20.00
Superstructure 10 by 30 feet	do	37.70

COMMERCIAL STATISTICS.

Vessels arriving and departing at Agate Bay, Minnesota.

Year.		Vessels.	Estimated tonnage.	Increase.
1885		174	295,800	
1886		263	460,000	164,200
1887		465	697,500	237,500
1888		749	1,436,000	738,500
1889		1,255	2,400,000	964,000
1890:				
Steam	968			
Sail	82			
		1,050	2,625,000	225,000
1891:				
Steam	1,188			
Sail and whaleback	62			
		1,250	2,915,000	290,000
1892:				
Steam	1,104			
Sail	186			
Whaleback	40			
		1,330	3,101,600	186,600
1893:				
Steam	1,016			
Sail	146			
Whaleback	16			
		1,178	2,386,200	—715,400
1894:				
Steam	1,432			
Sail	116			
Whaleback	70			
		1,618	3,236,000	849,800

Vessels arriving and departing at Agate Bay, Minnesota—Continued.

Year.		Vessels.	Estimated tonnage.	Increase.
1895:				
Steam	1,748			
Sail	350			
Whaleback	396			
		2,494	4,900,000	1,664,000
1896:				
Steam	1,444			
Sail	310			
Whaleback	228			
		1,982	4,860,000	—540,000
1897:				
Steam	1,428			
Sail	334			
Whaleback	302			
		2,064	6,192,000	1,882,000
1898:				
Steam	1,282			
Sail	380			
Whaleback	282			
		1,944	5,882,000	—360,000
1899:				
Steam	1,590			
Sail	550			
Whaleback	326			
		2,466	7,151,000	1,319,000
1900:				
Steam	2,190			
Sail or tow	254			
		2,444	7,087,600	— 63,400

Receipts and shipments.

Year.	Ore shipped.	Other freight received and shipped.	Total.	Year.	Ore shipped.	Other freight received and shipped.	Total.
	Tons.	*Tons.*	*Tons.*		*Tons.*	*Tons.*	*Tons.*
1885	225,484	10,895	236,379	1893	902,268	57,616	959,884
1886	304,396	21,954	326,350	1894	1,373,117	66,053	1,439,170
1887	394,252	6,620	400,872	1895	2,139,526	79,004	2,218,530
1888	509,964	30,352	540,316	1896	1,814,186	91,373	1,905,559
1889	924,054	31,731	955,785	1897	2,651,273	79,049	2,730,322
1890	984,215	37,268	1,021,483	1898	2,693,244	118,924	2,812,168
1891	1,000,052	41,181	1,041,233	1899	4,418,640	155,612	4,604,252
1892	1,304,885	54,477	1,359,362	1900	4,496,098	227,686	4,723,784

Beginning with 1890, amount of iron ore is stated in net tons; previous to that date, in gross tons.

Estimated value of freight received and shipped (exclusive of ore).

Year.	Amount.	Year.	Amount.
1887	$96,000	1894	$300,000
1888	212,000	1895	220,000
1889	222,000	1896	378,000
1890	246,000	1897	328,000
1891	225,000	1898	571,684
1892	320,000	1899	652,473
1893	360,000	1900	949,806

There were no new lines of transportation established last year, but several new boats were added to the old lines.

K K 3.

IMPROVEMENT OF HARBOR AT DULUTH, MINNESOTA, AND SUPERIOR, WISCONSIN.

The act of June 3, 1896, unified these harbors under the above title and provided for continuous contracts for improvement to the amount of $3,080,553.

This harbor consists now of the Duluth Canal, the Wisconsin entrance, Superior Bay, Allouez Bay, St. Louis Bay, and St. Louis River to the limits of the cities of Duluth and Superior, about 20 miles from the original natural entry, which before improvement was obstructed by shifting bars with but 9 feet of water over them. The bays were broad expanses of shallow water, averaging only 8 or 9 feet, except along the channel through them, where the depth was greater, but variable.

The previous project was practically completed July 1, 1897, and resulted in giving a good 16-foot navigation through the natural or Wisconsin entry, through the artificial Duluth Canal, over the Duluth Basin of 104 acres, along and parallel to the dock lines of Duluth and Superior, in Superior and St. Louis bays, and up the St. Louis River to New Duluth, near the head of navigation of the river, with well-defined channels from 85 to 300 feet in width.

The new project authorized by the act of June 3, 1896, provides for the widening and deepening to a navigable depth of 20 feet of the existing channels, for new channels in Allouez Bay and St. Louis River, for extensive turning and anchorage basins of a navigable depth of 20 feet at the junctions of two or more channels, for widening the Duluth Canal, and for rebuilding the piers at the Duluth Canal and Wisconsin entry, and finishing them off with concrete superstructures built of monolithic blocks.

The total amount expended previous to the commencement of operations under the present project was $1,548,183. The amount expended on the present project to June 30, 1900, was $1,448,034.65.

The title to the land covered by the present Duluth Canal, and that necessary for its enlargement, has now been acquired by deed of gift, by purchase directly from owners, and by purchase through condemnation proceedings, at a total cost of $53,919.05.

The award given in June, 1900, under condemnation proceedings for the land needed for the improvement at the Wisconsin entry and mouth of the Nemadji River and for an island in the St. Louis River were deemed so excessive by the officer then in charge that he recommended a discontinuance of the proceedings, and that the project for improvement in that vicinity be suspended until the land could be procured at a reasonable figure. This was approved by the Chief of Engineers, U. S. Army.

On April 15, 1901, an offer, in writing, to compromise the award of $72,620.05 made by commissioners under condemnation proceedings for 44.58 acres of land needed for the improvement at Wisconsin entry and the mouth of the Nemadji River, for the sum of $40,608.94, exclusive of fees and commissions, was made by the owners and representatives of about nine-tenths of the land. By letter of May 1, 1901, to the Chief of Engineers, this offer was recommended for acceptance, provided clear title to the lands in question could be obtained. The recommendation was approved by the Secretary of War May 13, 1901, and transmitted to the Attorney-General for his action. The United States attorney for the western district of Wisconsin now has the matter in hand, and it is believed that the land will be acquired by the United States at an early date. The recommendation of August 31, 1900, by the officer in charge, for the acquirement of four pieces of land in the vicinity of Spirit Lake, needed for the improvement in the St. Louis River, by condemnation or otherwise, was approved by the Secretary of War on September 12, 1900.

One of these pieces, containing 0.78 acre, has been acquired at a cost of $37.20. The other three pieces, containing 12.63 acres, are owned by the State of Minnesota, and were offered to the United States for the sum of $1,500.

By letter of April 2, 1901, to the Chief of Engineers, this offer was recommended for acceptance, if clear title to the lands in question could be acquired.

This recommendation was approved by the Secretary of War on April 9, 1901. On April 15, 1901, the United States district attorney for Minnesota was requested to prepare the necessary papers for the acquirement of the land, but up to the close of the fiscal year the land had not been acquired.

The award under condemnation proceedings for the marshy island in the St. Louis River, containing 10.63 acres, $2,187, will be accepted. The price originally asked was $15,000.

Operations under the contracts with Messrs. Williams, Green & Williams, and with Charles S. Barker, for dredging, to the amount of over $2,000,000, have been continued during the past fiscal year. Charles S. Barker died suddenly May 21, 1901, and operations, under his contract, since this date have been carried on by Rose Barker, special administratrix of his estate.

The total amount of material removed during the year, under these contracts, was 3,867,095 cubic yards. Of this amount 1,428,198 cubic yards have been taken out of Superior and Allouez bays, constituting dredging district No. 1; 781,197 cubic yards out of St. Louis Bay, constituting dredging district No. 2, and 1,657,700 cubic yards out of the St. Louis River above the St. Paul and Duluth Railway Bridge, constituting dredging district No. 3. Of the total amount, 2,079,784 cubic yards were dredged under contract with Charles S. Barker, and 1,787,311 cubic yards under contract with Williams, Green & Williams. The total amount dredged under these two contracts to June 30, 1901, is 15,626,995 cubic yards, of which Williams, Green & Williams have taken out 7,102,533 cubic yards and Charles S. Barker has taken out 8,524,462 cubic yards. To remove the total amount contemplated, 5,773,005 cubic yards remain to be dredged by November 1, 1902.

At the present rate of progress this amount of material can readily be removed by the date specified.

With the approaching completion of the approved project for dredging in this harbor arises the question of the most efficient and economical method of maintaining depths thus obtained. When the project is completed there will result more than 16 miles of dredged channels, varying in width from 120 feet to 600 feet, and basins of an aggregate area of about 250 acres, all with a safe navigable depth of at least 20 feet. Upon discontinuance of work these channels and basins will begin to deteriorate from running in of banks at the sides and from deposit of material brought down by the St. Louis and Nemadji rivers when in flood. The assistant engineer in charge of dredging operations estimates that for a period of five years from the completion of the present project there would have to be removed annually about 450,000 cubic yards of material, 300,000 cubic yards due to running in of the banks, and 150,000 cubic yards due to flood deposits and other causes.

Owing to the large territory to be covered and to the necessity for promptly meeting emergencies without the delays incident to the preparation of public notices, contracts, etc., it appears very desirable that the maintenance of these channels and basins should be effected by plant owned and operated by the United States. Such a plant, consisting of a powerful dipper dredge, two tugs, three large dump scows, and a decked scow, is estimated to cost $143,000. With this plant it is estimated that the annual cost of maintenance, exclusive of superintendence, surveys, office expenses, etc., for the first five years will amount to about $33,750, as against an estimated cost of about $67,500 if the same work is done by contract. With this plant once constructed, it seems reasonably certain that by its use the harbor formed by operations under the present project can be maintained at a total annual cost equivalent to less than 4 mills per ton on the net vessel freight of the harbor for the year. This plant would be needed by April, 1903, and should be constructed and be ready for operation before that date. Attention is invited to the accompanying report of Mr. F. L. Dever, U. S. assistant engineer, upon the details of dredging operations.

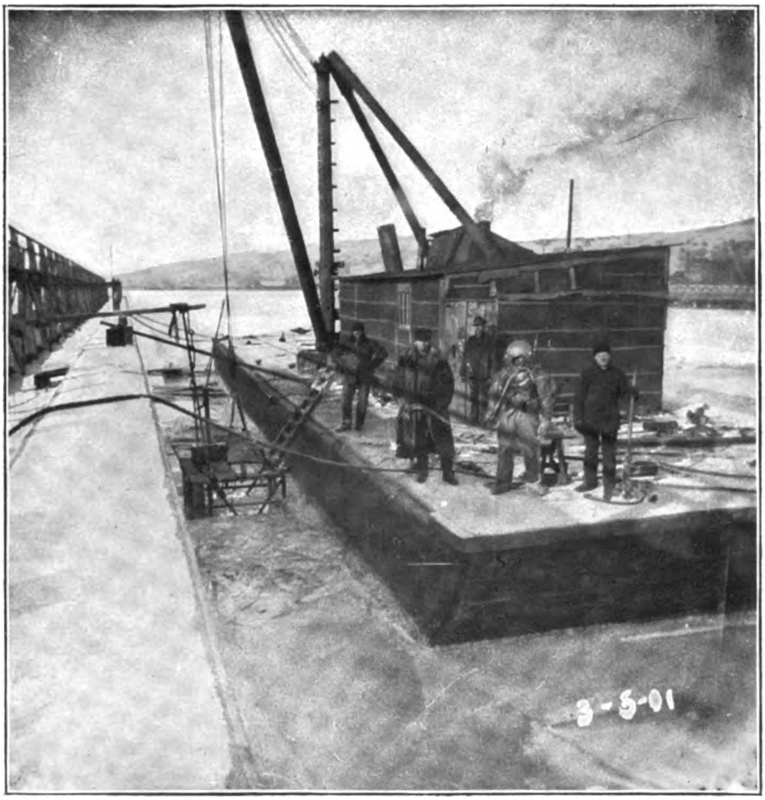
Under the contract with Butler-Ryan Company for the substructure for the new north pier 11 cribs were sunk and filled. Ten of these cribs were each 24 feet wide and 100 feet in length. The outer crib was 24 to 36 feet wide and 100 feet long. The first of these cribs was placed in position on July 20, 1900, and the last on December 12, 1900.

Deck timbers were laid on all of these cribs, and on two additional ones which had been sunk during the previous fiscal year, between July 30, 1900, and February 16, 1901. Between January 7 and February 11, 1901, sixteen 1-inch steel connecting plates, 2 feet 10 inches by 7 feet, which form a part of the protection plates of the cribs, were fastened by 28 patch bolts in each plate.

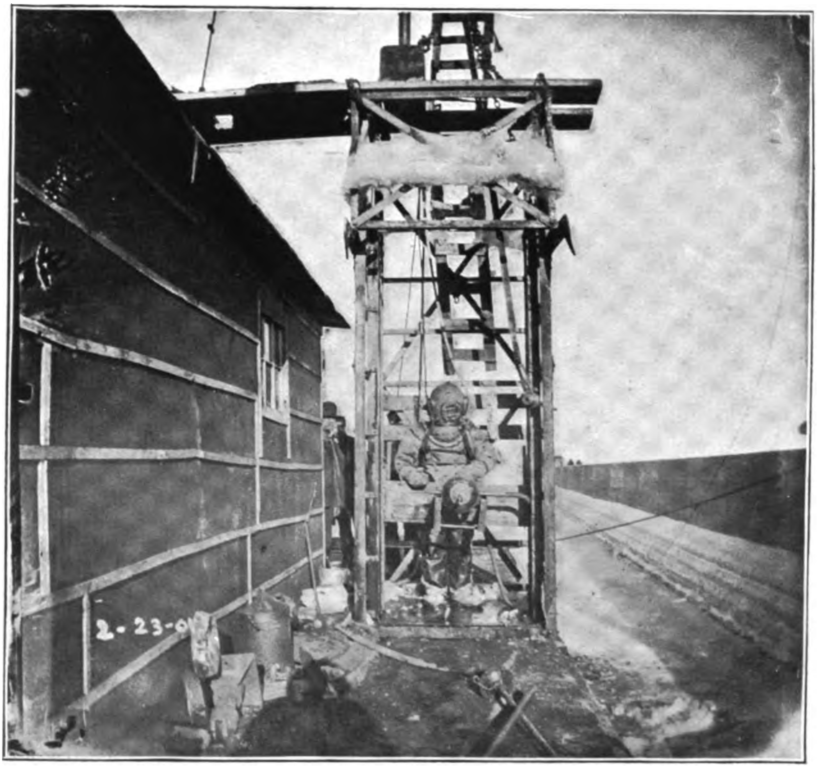
These patch bolts were inserted under water by a diver, provided with pneumatic tools, and working in an ingenious suspended cage (shown in the accompanying photographs). This difficult work was executed in a very satisfactory manner during severe winter weather.

A well was provided in the pierhead crib, to be used in connection with a self-recording gauge, which it is proposed to establish during the present season. The contract with Butler-Ryan Company for the substructure of the new north pier was completed February 16, 1901, at a cost of $168,582.01.

Additional work pertaining to the substructure of the north pier, but outside of this contract, amounted to $9,283.78, while operating plant, office expenses, engineering, inspection, superintendence, and incidentals aggregated $16,641.90, making the total cost of the substructure $194,507.69. Between February 15 and March 11, 1901, Butler-Ryan Company under special agreement secured, by patch bolting, thirteen 1 inch by 2 ft. by 7 ft. connection plates at crib joints on the south pier, the work being performed as previously described.



VIEW OF DRILL SCOW AND PNEUMATIC PATCH-BOLTING PLANT, FOR CONNECTING STEEL PLATES UNDER WATER COVERED WITH ICE, AT NEW SOUTH PIER. DIVER'S CAGE IN PLACE. MARCH 5, 1901.



VIEW OF DIVER'S CAGE, USED IN DRILLING, TAPPING, ETC., UNDER WATER, FOR SECURING CONNECTION PLATES AT CRIB JOINTS. CAGE RESTING ON THE DECK OF SCOW WITH DIVER IN PLACE, DRILL, DRILL REST, ETC. SIZE, 4′ 4″ BY 4′ 4″ BY 12′. ICE NEAR TOP SHOWS DEPTH TO WHICH IMMERSED. SOUTH PIER ON RIGHT SHOWN COVERED WITH ICE NEAR WATER LINE. FEBRUARY 23, 1901.

Under contract with the Duluth Dredge and Dock Company the old south pier was removed in November and December, 1900, at a cost of $15,000. This pier was about 1,200 feet in length, and was composed of rock-filled timber cribs and superstructure, with riprap revetment at the base of the former. The work was executed without any special difficulty by a powerful dipper dredge. In removing this pier it was noted that those portions of the 1⅛-inch square driftbolts, which had been embedded under water in timber for twenty-eight years, were almost free from rust and still bright. Those portions exposed to water at seams in the timber had lost about 1 per cent in cross section by corrosion.

During November and December, 1900, a riprap embankment was built along both sides of the south pier from stone obtained in removing the old south pier.

On the north side of the pier the embankment extends from the outer end of the pier westward for a distance of 325 feet. Originally it sloped from the water surface at the pier to nothing at a distance of 40 feet from the pier, but has since been beaten down by storms.

The shoal which lay between the old and new south piers, and which had a least depth of but 10 feet, was removed by dredging in April and May, 1901.

A pipe well was sunk at the rear side of each of the new piers, on the center line of Lake avenue, for carrying such pipes, electric cables, etc., as may be permitted under the Duluth Canal.

In February, 1901, a portion (16 ft. by 16 ft. by 50 ft.) of the old protection pier, which had been destroyed by a severe storm in October, 1900, was found in the eastern end of the canal about 75 feet north of the center line.

It was removed after due public notice by Whitney Brothers, of West Superior, Wis., lowest bidders, early in April, 1901, for the sum of $600.

By contract approved June 4, 1901, with Whitney Brothers, 9,000 tons of riprap, more or less, at $1 per ton, are to be placed along the new piers of the Duluth Canal, partly as a protective revetment against underscour, and partly as an embankment to retain dredged material to be deposited back of the new north pier. Within the limits of the canal this revetment will extend 20 feet from the piers, and will slope from 19 feet below low-water datum at the piers to a depth greater than 20 feet below datum at a distance of 10 feet from the piers.

At the close of the fiscal year 1,078.5 tons of riprap had been delivered under this contract. Careful measurements taken at frequent intervals on the south pier of the Duluth Canal by Mr. J. H. Darling, United States assistant engineer, show that the settlement of the cribs has been remarkably uniform, and has averaged about 2 inches in all since the cribs were placed.

Attention is invited to the accompanying report of Mr. Darling for details upon this subject and other operations previously described relating to pier construction.

Under contract approved March 25, 1899, with Charles Stone, of St. Paul, Minn., for the concrete superstructure of the south pier of the Duluth Canal, 135 monolithic blocks, containing 6,438.66 cubic yards of concrete, were built in place during the fiscal year. The concrete superstructure for this pier was completed on October 16, 1900, in ninety-two working days out of one hundred and eight days of elapsed time.

Under the contract approved May 15, 1900, with Mr. Stone for setting concrete footing blocks and building monolithic concrete superstructure on the north pier of the Duluth Canal, 569 footing blocks were set during the period between March 4 and April 9, 1901. The work of building in place the monolithic concrete blocks was commenced April 25, 1901, and by the close of the fiscal year 80 blocks, containing 3,512.22 cubic yards of concrete, had been completed, the work occupying forty-four out of sixty-six days embraced in this period. Photographs are submitted showing the character of the concrete work on the piers.

Under contract with the Northwestern Lime Company, of St. Paul, Minn., 12,073 barrels of Atlas Portland cement have been delivered during the fiscal year, of which number 9,049 barrels have been accepted and paid for and 3,024 barrels are now undergoing test.

Testing of cement and other materials for concrete work has been regularly prosecuted throughout the fiscal year, and the results carefully recorded and tabulated.

The following is a summary of the work done in this line during the year:

Tests for fineness have been made of 438 samples of sand used on the work.
Tests for fineness on 367 samples of cement.
Tests for specific gravity on 20 samples of cement.
Tests for constancy of volume on 764 samples of cement.
Tests for suitableness for concrete on 9 samples of gravel.
Briquettes made, 2,694.
Briquettes broken, 4,381.

By contract approved January 8, 1901, the Magnetite Foundry Company, of St. Louis, Mo., lowest bidders, have furnished 98 ornamental iron lamp-posts and 220 globes, for lighting the piers at the Duluth Canal, for the sum of $3,235.74. Most of the lamp-posts for the south pier have been set in place. The rest will be set when the light-house, now in course of erection on this pier, has been completed. Those for the north pier will be set toward the close of the present season.

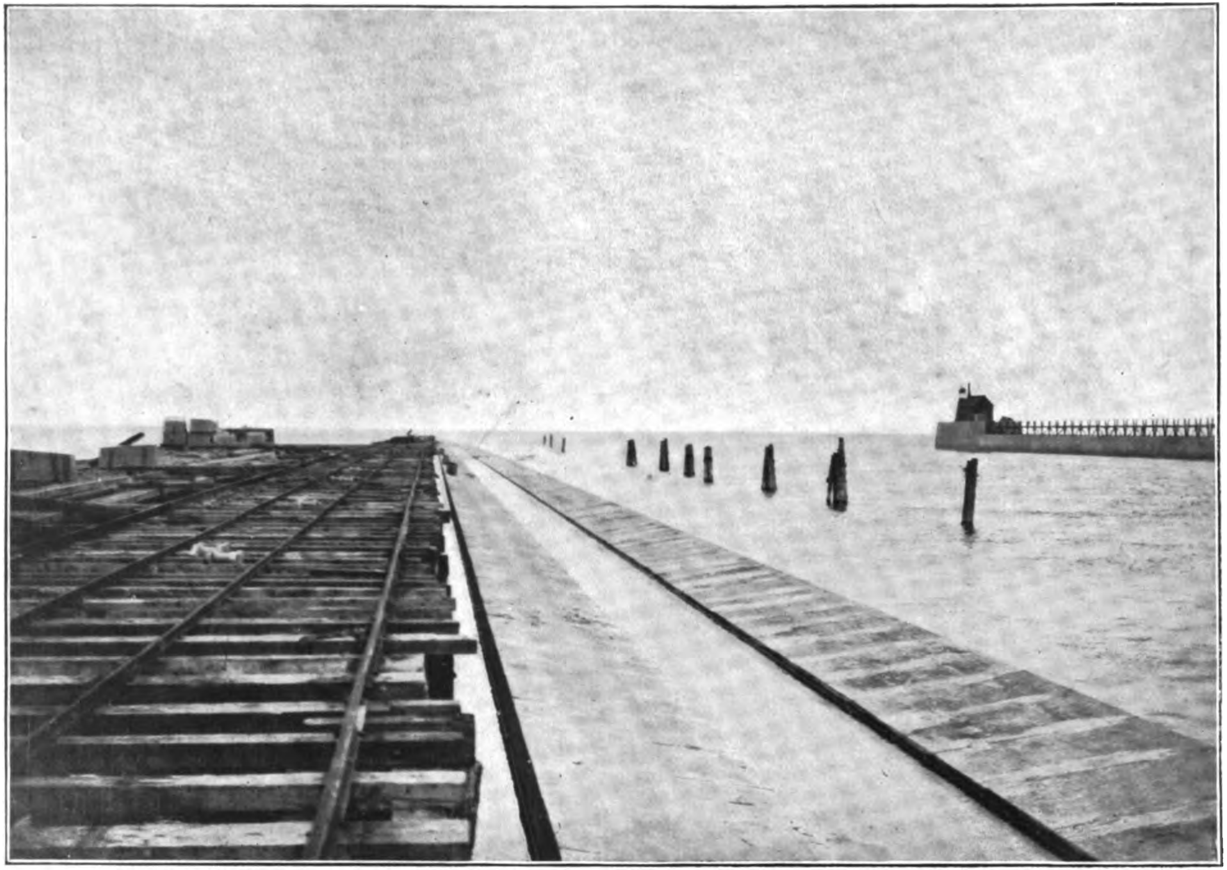
All operations relating to concrete work upon the canal piers, testing of materials for concrete, preparation of designs for lamp-posts and placing these posts, have been carried on under the direct superintendence of Mr. Clarence Coleman, United States assistant engineer.

Observations have been made in the Duluth Canal on the height and velocity of waves during storms, and dynamometers have been constructed, but not yet installed, for measuring the relative effect of wave impact at the Duluth Canal, Superior entry, and at several other harbors in this district.

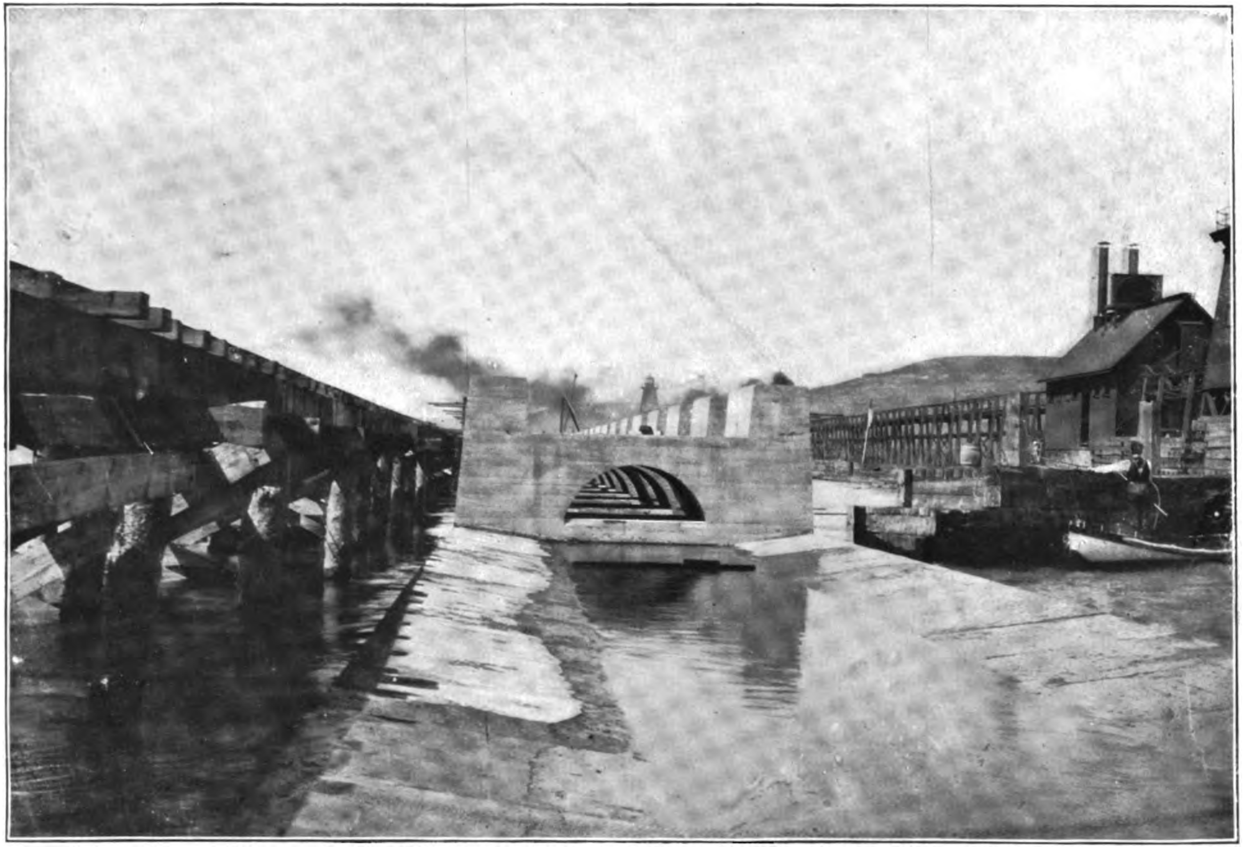
During the past winter a survey of the harbor and of the St. Louis River was made, 62,947 soundings being taken through ice varying in thickness from 4 to 30 inches, the average thickness being 15 inches. These soundings were platted and a map forwarded to the Department March 1, 1901.

An interesting paper by Mr. J. H. Darling, United States assistant engineer, showing the relative stability of stones of different densities when acted upon by similar forces accompanies this report.

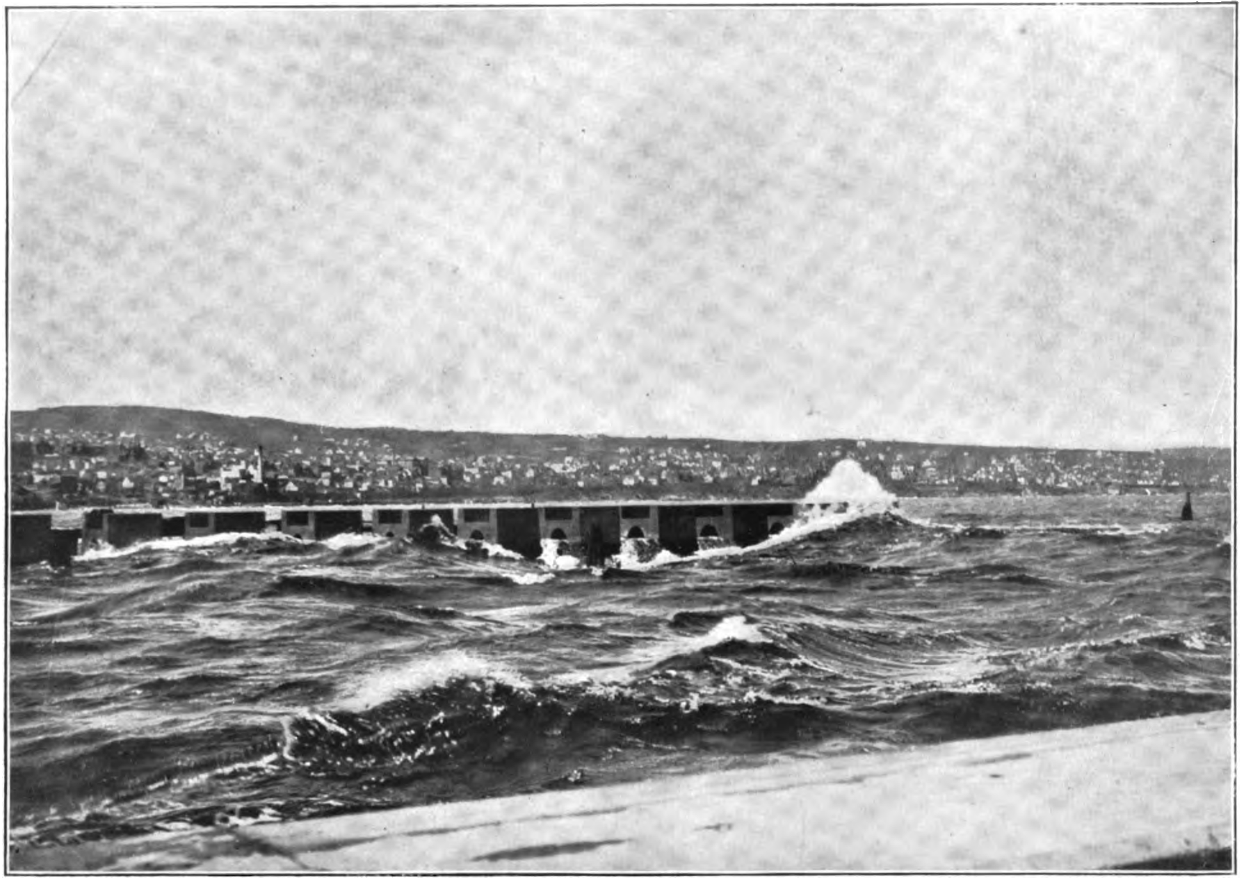
The contracts yet to be made are for the construction of retaining and division walls, filling and parking of grounds, and building a watchman's house at the Duluth Canal, rebuilding piers at Wisconsin entry, and finishing them off with concrete superstructures built of monolithic blocks.



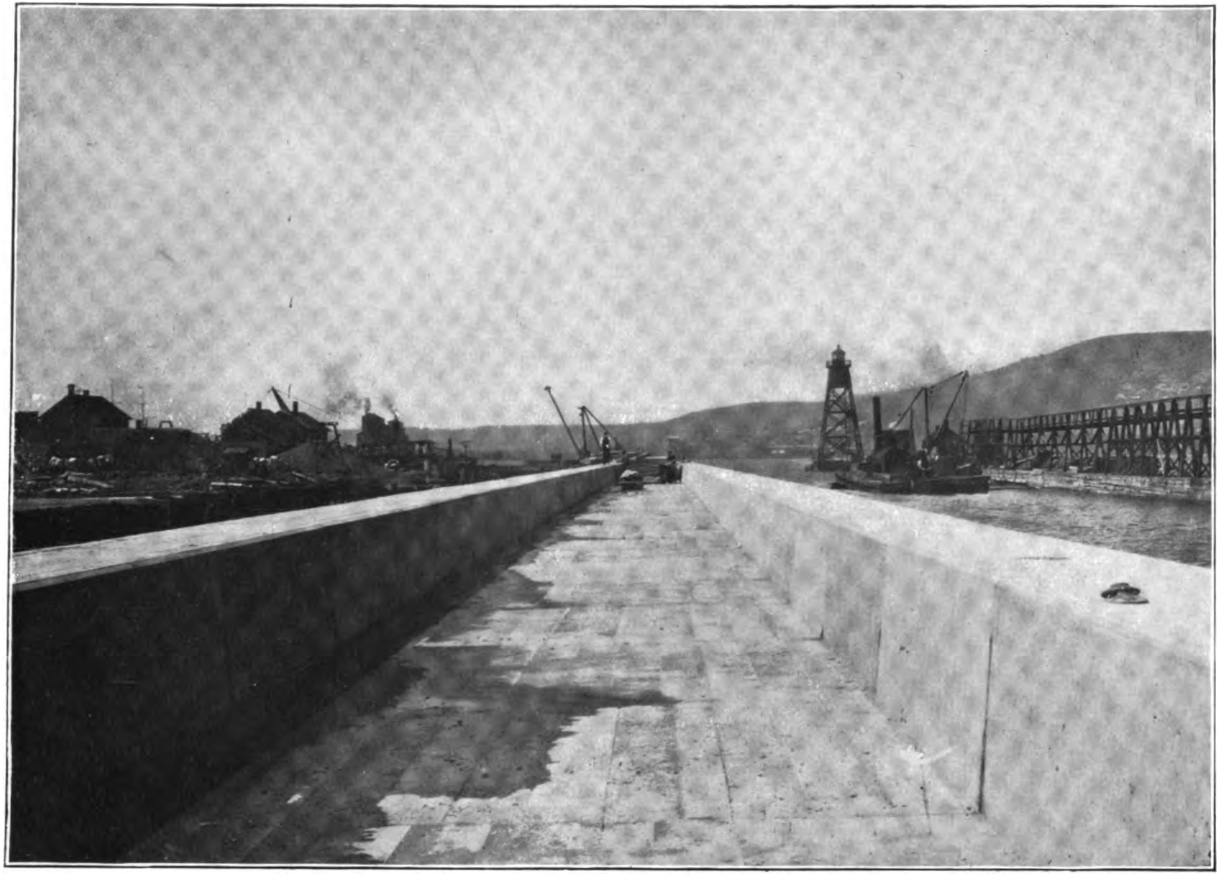
VIEW SHOWING FOOTING BLOCKS OF NORTH PIER BEFORE MONOLITHIC BLOCKS ARE BUILT IN PLACE. COMPLETED SOUTH PIER TO THE RIGHT WITH TEMPORARY LIGHT-HOUSE AND TRESTLE. APRIL 18, 1901.



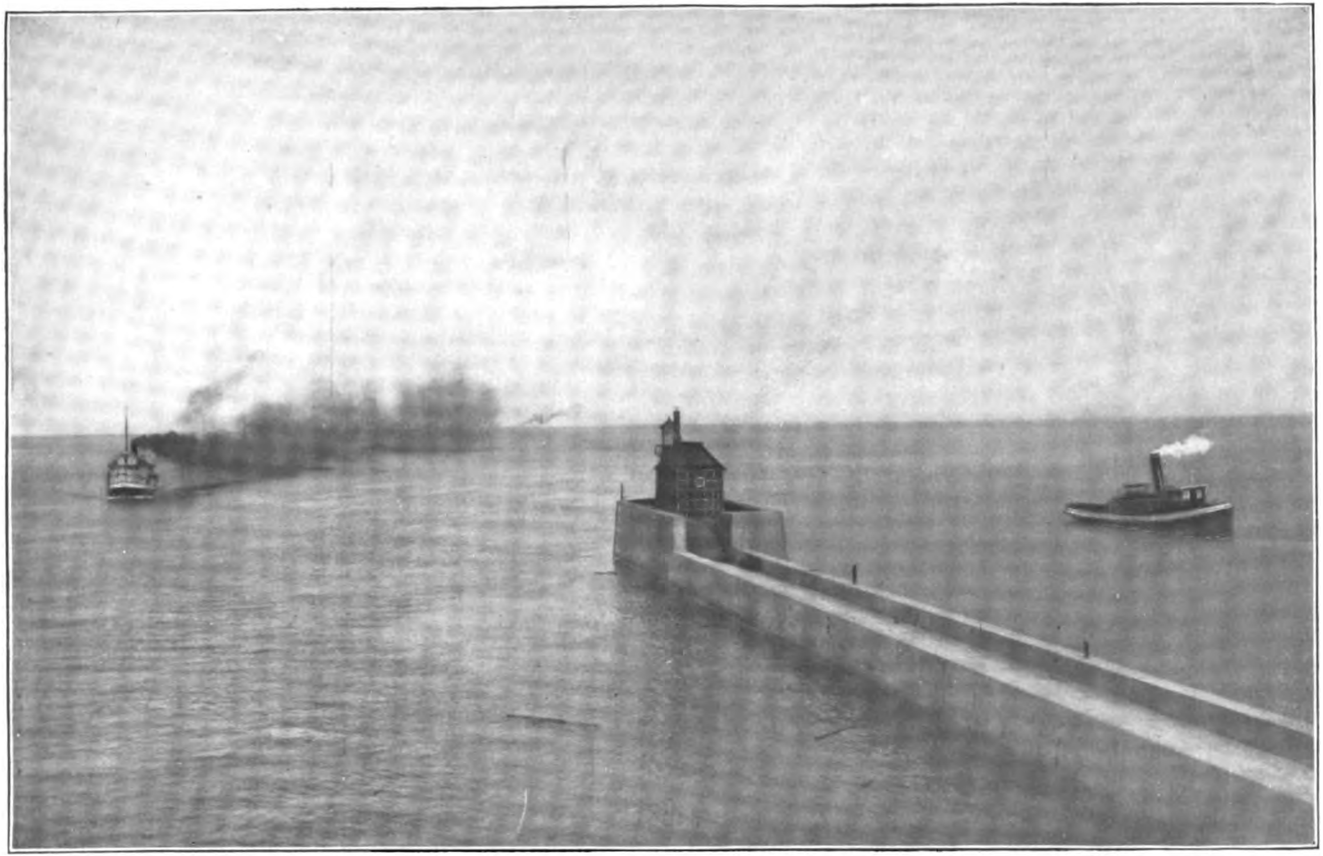
CROSS SECTION OF MAIN-PIER DOUBLE-PARAPET BLOCKS. SOUTH-PIER FOOTING BLOCKS IN FOREGROUND. JULY 11, 1900.



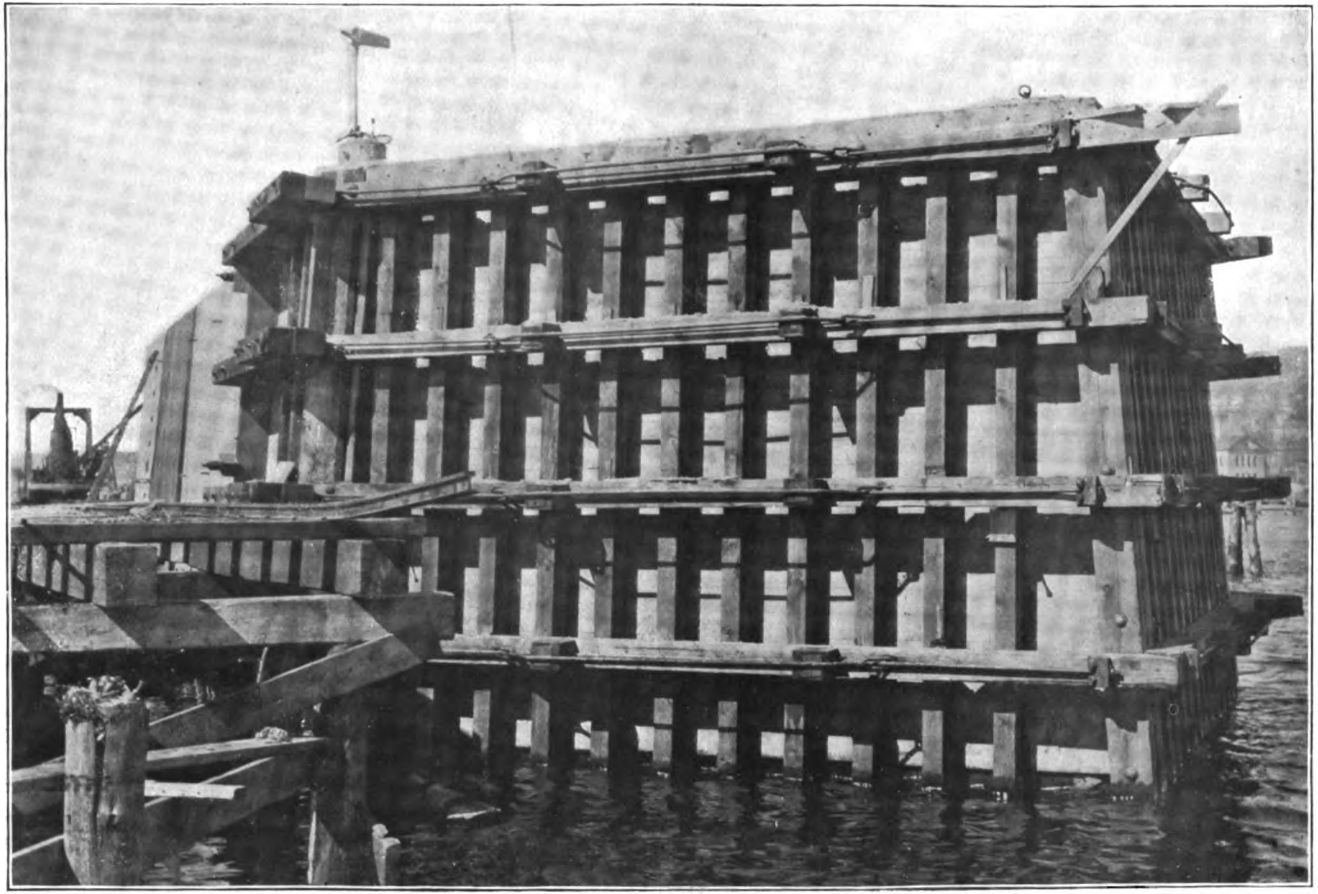
ALTERNATE MONOLITHIC CONCRETE BLOCKS, NORTH PIER, DULUTH CANAL, MAY 24, 1901, SHOWING WAVES DUE TO STORM OF PREVIOUS DAY



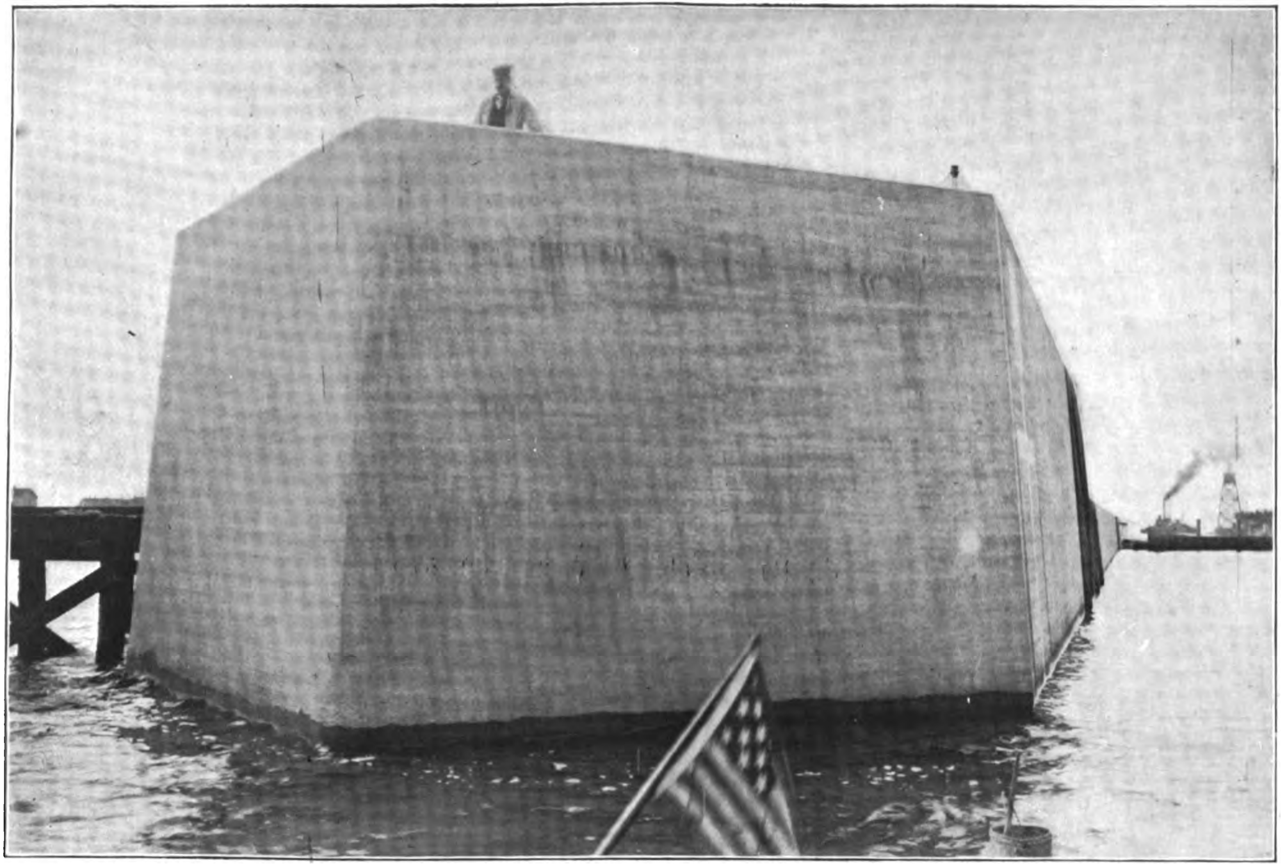
VIEW ALONG PROMENADE OF SOUTH PIER DURING CONSTRUCTION, LOOKING WEST. AUGUST 28, 1900.



PERSPECTIVE OF OUTER END OF SOUTH PIER, SHOWING COMPLETED CONCRETE SUPERSTRUCTURE WITH TEMPORARY LIGHTHOUSE AND FOG SIGNAL ON PIERHEAD. NOVEMBER 11, 1900.



MOLD ON CUTWATER BLOCK, PIERHEAD OF SOUTH PIER, FILLED WITH CONCRETE. AUGUST 28, 1900.



CUTWATER BLOCK, PIERHEAD OF SOUTH PIER, AFTER MOLD WAS REMOVED. SEPTEMBER 27, 1900.

The sundry civil act of March 3, 1901, appropriated $320,000 for continuing the improvement of this harbor, making $2,620,825.50 thus far appropriated of the total amount, $3,080,553, authorized to be expended, and leaving a balance of $459,727.50 not yet appropriated.

To meet liabilities under existing contracts and those yet to be made, for payment for land, and for other necessary expenses to June 30, 1903, exclusive of work upon the Wisconsin Entry piers, it is estimated that $711,300 will be required. On July 1, 1901, there was an available balance of $510,289.84. This, with the balance of $459,727.50 yet to be appropriated, amounts to the sum of $970,017.34, leaving but $258,717.34 available for rebuilding piers at Wisconsin entry and finishing them off with concrete superstructures built of monolithic blocks, in accordance with the modified project approved by the Secretary of War August 14, 1896, E. D. 15873/1. The present piers are composed of rock-filled timber cribs and superstructure, 20 feet in width, built in 1867–1873, and sunk in water of an average depth of about 8 or 10 feet, the object at the time being to secure a channel 12 feet in depth. With the growth of commerce it has been necessary to increase this depth from time to time by dredging, until at the present time the average mid-channel depth is about 24 feet. As a consequence the crib bottoms are about 15 feet above the bottom of the present channel, and due to this cause considerable settlement and tilting of the cribs has resulted in the past, in extreme cases the difference in level between the inner and outer edges of the top of a crib being as much as 3 feet, while in alignment the departure from a straight line is in one case as much as 8 feet.

This apparent displacement of the cribs is possibly due, in some measure, to irregularities in location when originally sunk, but probably in greater part to the cause previously described.

All motion of the cribs has practically ceased since 1897, when they were protected by riprap on both sides, over 53,000 tons of stone being used for this purpose.

To replace the present piers by new ones, with concrete superstructures, is estimated to cost $925,000, the aggregate length of the two proposed piers being 6,200 feet. The probable balance available for this work from the appropriations authorized by act of June 3, 1896, is $258,717.34, leaving $666,282.66 to be appropriated outside of that act if new piers are built. To place concrete superstructures on the present cribs and to extend the inner end of the south pier, making the aggregate length of the two piers 5,400 feet, is estimated to cost $225,000. This work could be done within the appropriations authorized by the act of June 3, 1896.

This would not be in accordance with the approved project, and would, in my opinion, be of very doubtful expediency, owing to the present condition of the cribs.

In connection with the estimate for new piers at Wisconsin entry, it is proper to invite attention to the fact that the appropriation of $3,080,553 authorized by the act of June 3, 1896, was based upon the estimate submitted by the commission of officers of the Corps of Engineers, constituted by Special Orders, No. 40, Headquarters Corps of Engineers, United States Army, August 18, 1894.

This estimate covered only the removal of 20,870,376 cubic yards of material by dredging.

When present and prospective contracts are completed there will have been removed 21,400,000 cubic yards of material, and in addition land to the amount of about $100,000 acquired, new piers built at the Duluth Canal at a cost of about $635,000, repairs and riprap for piers at Wisconsin Entry, $66,000, with an estimated remaining balance of $258,717.34 toward new piers for the entry. In other words, over $1,000,000 more work will have been done for the amount authorized than was originally contemplated.

The lake commerce of this harbor during the past season of navigation amounted to 11,725,245 net tons of freight, valued at $135,109,196—the largest tonnage in the history of the port.

Since the United States took charge of this harbor its commerce has amounted to more than 90,485,000 tons, valued at over $1,453,352,000.

The system of vessel reports has been kept up, and the commercial statistics accompany this report.

These statistics are as accurate as it is practically possible to make them, being compiled from the individual reports of each trip of every vessel, in or out, made directly to this office.

The general local charge of this harbor has remained with Mr. J. H. Darling, assistant engineer, with Mr. F. L. Dever, assistant engineer, in charge of the dredging, and Mr. Clarence Coleman, assistant engineer, in charge of concrete work. Mr. James L. Owen continues as chief clerk, in charge of the office.

This work is in the collection districts of Duluth, Minn., and Superior, Wis., Marquette, Mich., being the port of entry for the latter. The nearest light-houses are at the two entrances.

Money statement.

July 1, 1900, balance unexpended	$902,790.85
Amount appropriated by sundry civil act approved March 3, 1901	320,000.00
	1,222,790.85
June 30, 1901, amount expended during fiscal year	556,931.11
July 1, 1901, balance unexpended	665,859.74
July 1, 1901, outstanding liabilities	155,569.90
July 1, 1901, balance available	510,289.84
July 1, 1901, amount covered by uncompleted contracts	540,200.00
Amount (estimated) required for completion of existing project	459,727.50
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	[1]459,727.50
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

Abstract of appropriations for improving harbor at Duluth, Minn., and Superior, Wis.

By act of Congress of June 3, 1896	$50,000.00
By sundry civil act of—	
June 4, 1897	437,500.00
July 1, 1898	770,138.00
March 3, 1899	300,000.00
June 6, 1900	793,187.50
March 3, 1901	320,000.00
Total	2,670,825.50

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[1] In addition to this amount, $100,000 will be required for work on Superior entry piers, and $143,000 for a dredging plant for maintenance of improvement, as heretofore explained.

The following statement shows the manner in which the appropriations have been expended since June 30, 1896. The amount expended under the different classes of work includes the cost of soundings, superintendence, buoying, and contingencies.

Dredging	$1,385,046.71
Duluth Canal piers	500,000.00
Wisconsin entry piers	66,000.00
Purchase of land	53,919.05
Total	2,004,965.76

Abstract of appropriations for improving harbor at Duluth, Minn.

By act of Congress approved—	
March 3, 1871	$60,000.00
June 10, 1872	50,000.00
Allotted from act passed March 3, 1873	36,049.20
By act of Congress approved—	
June 23, 1874	10,000.00
March 3, 1875	35,000.00
August 14, 1876	15,000.00
June 18, 1878	30,000.00
March 3, 1879	25,000.00
June 14, 1880	25,000.00
March 3, 1881	40,000.00
By act of Congress passed August 2, 1882	45,000.00
By act of Congress approved—	
July 5, 1884	45,000.00
August 5, 1886	56,250.00
By act of Congress passed August 11, 1888	80,000.00
By act of Congress approved—	
September 19, 1890	100,000.00
July 13, 1892	125,000.00
By act of Congress of August 18, 1894	75,000.00
Total	852,299.20

The following statement shows the manner in which the appropriations have been expended. The amount expended under the different classes of work includes the cost of soundings, superintendence, buoying, and contingencies.

Total amount expended to June 30, 1897:	
Breakwater	$110.000.00
Dredging	644,638.55
Canal piers, etc	97,660.65
Total	852,299.20
Expended prior to present project:	
Breakwater	110,000.00
Canal piers, etc	45,698.33
Dredging	122,354.05
Total	278.052.38
Expended under the project adopted in 1881:	
Canal piers, etc	51,962.32
Dredging	522,284.50
Total	574,246.82

Abstract of appropriations for improving harbor at Superior Bay and St. Louis Bay, Wisconsin.

By act of Congress approved—	
March 3, 1867	$63,000.00
April 10, 1869	45,000.00
July 7, 1870	40,000.00
March 3, 1871	60,000.00
June 10, 1872	50,000.00

Allotted from act approved March 3, 1873	$63,950.80
Allotted from appropriation for "Repairs of harbors on Northern lakes"	5,433.00
By act of Congress approved—	
August 14, 1876	3,000.00
June 18, 1878	3,000.00
March 3, 1879	5,000.00
June 14, 1880	5,000.00
March 3, 1881	10,000.00
August 2, 1882	40,000.00
July 5, 1884	45,000.00
August 5, 1886	22,500.00
By act of Congress—	
Passed August 11, 1888	50,000.00
Approved September 19, 1890	65,000.00
Approved July 13, 1892	70,000.00
Of August 18, 1894	50,000.00
Total	695,883.80
Aggregate	4,219,008.50

Expenditures.

Amount expended under original project, adopted in 1867	$258,000.00
Amount expended under project recommended by Board of Engineers in 1873	77,513.26
Amount expended under present project to June 30, 1897	360,370.54
Total	695,883.80

The following statement shows the manner in which the appropriations have been expended. The amount expended under the different classes of work includes the cost of examinations, soundings, superintendence, buoying, and contingencies.

Repairs and beach protection	$13,233.00
Construction and repair to piers	334,278.64
Dredging	348,372.16
Total	695,883.80

LIST OF EXISTING CONTRACTS.

Contracts for dredging some 21,000,000 cubic yards of material (with option on the part of the United States of increasing amount to 26,400,000 cubic yards), with Williams, Green & Williams, of Duluth, Minn., for one-half; contract dated March 18, 1897; work commenced June, 1897, and to be completed by November 1, 1903, contingent upon appropriations being made; Charles S. Barker, of West Superior, Wis., for one-half, contract dated March 18, 1897, approved May 8, 1897, work begun in June, 1897, and to be completed by November 1, 1903, contingent upon appropriations being made.

All sand and soft material:

District No. 1, 7½ cents per cubic yard, scow measurement.

District No. 2, 8 cents per cubic yard, scow measurement.

District No. 3, 10 cents per cubic yard, scow measurement.

Contract with Charles Stone, of St. Paul, Minn., for concrete superstructure for north pier, Duluth, Minn., canal pier, dated May 3, 1900, approved May 15, 1900; work to commence in spring of 1900, and be completed October 15, 1901.

Price for setting concrete footing blocks, $7.40 per block.

Building in place concrete superstructure, $5 per cubic yard concrete. Cement furnished by the United States.

Contract with Whitney Bros., of West Superior, Wis., for furnishing and placing 9,000 tons of riprap for protective embankment against Duluth Canal piers, dated May 14, 1901, approved June 4, 1901; work to commence June 21, 1901, and be completed October 1, 1901. Prices: One dollar per net ton for riprap in place, and $2 per cubic yard for crushed rock.

COMMERCIAL STATISTICS, DULUTH, MINN.

Comparative statement of arrivals and clearances for 1899 and 1900.

Year.	Arrivals.	Clearances.	Total.	Tonnage.	Average tonnage.
1900	3,711	3,616	[a]7,327	9,002,039	[b]1,398
1899	3,811	3,751	[c]7,562	9,437,065	[b]1,362
Decrease	100	135	235	435,026	+36

[a] Steam, 6,204; sail, 1,123. [b] Exclusive of tugs with freight. [c] Steam, 5,969; sail, 1,593.

Principal domestic commodities received and shipped by lake, 1900.

Receipts.	Tons.	Shipments.	Tons.
Coal	958,286	Wheat	498,608
Cement and lime	61,148	Flour	304,989
Building stone	4,981	Other grains	149,318
Salt	31,327	Structural iron or steel	836
Machinery	110	Iron ore	4,270,429
Manufactured iron	29,718	Copper	16,278
Fish, kerosene oil, etc	1,808	Miscellaneous merchandise	52,996
General merchandise	112,230	Lumber	559,890
Sand and gravel	35,521	Wool	978
Total	[a]1,235,119	Total	5,854,822

	Net tons.	Valuation.[b]
Total receipts	1,235,119	17,753,906
Total shipments	5,854,822	51,945,045
Receipts and shipments	7,089,441	69,698,951

[a] These figures do not include some 43,540,000 feet of logs in rafts, and 210,415 ties.

[b] Valuations are based on average wholesale prices on board vessels for exports and landed on wharves for imports.

Passengers arriving	30,890
Passengers departing	38,882
Total	69,772

Receipts of coal and shipments of flour eastward for eighteen years.

Year.	Coal.	Flour.	Year.	Coal.	Flour.
	Tons.	*Tons.*		*Tons.*	*Tons.*
1883	420,000	91,896	1892	1,168,068	288,483
1884	372,000	79,801	1893	1,124,771	301,988
1885	695,000	113,190	1894	932,679	546,580
1886	736,000	133,036	1895	581,682	407,003
1887	1,041,000	129,627	1896	662,123	372,944
1888	1,435,000	171,223	1897	682,274	356,083
1889	1,045,000	198,053	1898	818,787	321,012
1890[a]	735,995	149,112	1899	892,204	331,943
1891	778,982	170,774	1900	958,286	304,989

[a] Coal receipts prior to 1890 are given for the head of the lake (Duluth and Superior); since then for Duluth only.

The storage capacity of Duluth-Superior elevator system is 36,400,000 bushels, and that of Duluth elevators proper 15,800,000 bushels.

The following table gives the receipts and shipments of wheat for thirty years:

Year ending Dec. 31—	Receipts.	Shipments.	Total.	Year ending Aug. 31—	Receipts.	Shipments.	Total.
	Tons.	*Tons.*	*Tons.*		*Tons.*	*Tons.*	*Tons.*
1900	954,463	923,292	1,877,755	1883	141,234	137,607	278,841
1899	1,649,458	1,242,606	2,892,064	1882	97,987	99,264	197,251
1898	1,992,399	1,561,537	3,553,936	1881	99,965	85,966	185,931
1897	1,442,082	1,141,259	2,583,341	1880	40,430	43,610	84,040
1896	1,748,780	1,296,862	3,045,642	1879	54,722	44,617	90,339
1895	1,487,981	1,092,516	2,580,497	1878	54,092	54,000	108,092
1894	750,000	763,110	1,513,000	1877	13,817	15,117	28,934
1893	987,312	1,011,025	1,998,337	1876	43,536	41,292	84,828
1892	1,399,817	932,222	2,332,039	1875	34,137	32,436	66,573
1891	1,144,082	1,058,449	2,202,531	1874	67,224	72,725	139,949
1890	460,244	427,725	887,969	1873	59,444	47,495	106,939
1889	513,827	409,410	923,237	1872	27,948	28,531	56,479
1888	239,802	404,485	644,287	1871	16,703	16,345	33,048
1887	514,089	585,558	1,059,647				
1886	675,977	530,048	1,206,025				
1885	446,590	421,973	868,563				
1884	411,688	345,537	758,235				

The above figures show the movement of wheat at the head of the lake (Duluth and Superior combined).

Average vessel tonnage for sixteen years.

Year.	Tons.	Year.	Tons.	Year.	Tons.
1885	761	1891	1,129	1897	1,386
1886	778	1892	1,095	1898	[a] 1,480
1887	812	1893	1,160	1899	[a] 1,435
1888	887	1894	1,217	1900	[a] 1,444
1889	970	1895	1,172		
1890	1,081	1896	1,257		

[a] Duluth and Superior. Exclusive of tugs.

Comparative statement of arrivals and clearances of vessels at Duluth for twenty-four years.

Year.	Arrivals.	Clearances.	Total.	Year.	Arrivals.	Clearances.	Total.
1877	329	228	557	1889	1,263	1,265	2,528
1878	406	343	749	1890	1,266	1,268	2,534
1879	502	497	999	1891	1,444	1,451	2,895
1880	524	524	1,048	1892	1,735	1,747	3,482
1881	666	660	1,326	1893	1,642	1,663	3,305
1882	833	832	1,665	1894	2,234	2,280	4,514
1883	796	779	1,475	1895	3,786	3,782	7,568
1884	888	903	1,791	1896	3,737	3,686	7,423
1885	808	989	1,979	1897	3,120	3,109	6,229
1886	1,026	995	2,021	1898	3,464	3,444	6,908
1887	1,237	1,238	2,475	1899	3,811	3,751	7,562
1888	1,100	1,100	2,200	1900	3,711	3,616	7,327

Comparative statement of imports and exports.

Year.	Imports.	Duties.	Tonnage duty.	Total duties.	Value of domestic exports.	Value of foreign exports.
1888	$86,901	$2,909.00	$23.40	$2,932.40	$1,207,858	....
1889	21,852	2,931.00	49.80	2,980.80	1,405,447	....
1890	48,027	5,255.86	13.20	5,269.06	1,521,751	....
1891	155,446	4,764.97	86.40	4,851.37	2,079,173	....
1892	117,759	16,706.28	127.84	16,834.12	1,837,936	....
1893	130,797	14,496.34	154.89	14,651.23	1,419,699	....
1894	111,340	10,163.90	82.62	10,246.52	1,696,950	$815,356
1895	1,350,264	254,435.92	114.06	254,549.98	2,200,164	1,224,086
1896	1,154,123	220,638.81	95.46	220,734.27	2,857,742	1,075,379
1897	2,167,822	520,201.54	....	520,201.54	2,230,834	2,009,685
1898	1,300,568	403,731.62	23.10	403,754.72	2,526,766	1,254,834
1899	2,720,620	908,922.79	69.30	908,992.09	3,858,719	2,625,120
1900	1,559,325	538,583.40	....	538,583.40	2,496,472	1,487,141

Number of vessels of all kinds enrolled at Duluth custom-house up to April 1, 1901, 305. Total gross registered tonnage, 349,434. Increase of 51 vessels over 1899.

Opening and closing of navigation.

Year.	Opening.	Closing.	Year.	Opening.	Closing.
1885	Apr. 27	Nov. 29	1894	Apr. 19	Dec. 15
1886	May 7	Dec. 14	1895	Apr. 15	Dec. 16
1887	May 4	Dec. 28	1896	Apr. 12	Dec, 17
1888	May 11	Dec. 31	1897	Apr. 15	Dec. 14
1889	Apr. 11	Dec. 4	1898	Apr. 5	Dec. 12
1890	Apr. 16	Dec. 8	1899	Apr. 29	Dec. 19
1891	Apr. 30	Dec. 6	1900	Apr. 22	Dec. 18
1892	Apr. 16	Dec. 30	1901	Apr. 29	....
1893	May 9	Dec. 1			

Detailed statement of arrivals, clearances, and registered tonnage of vessels through the Duluth Canal for the season of 1900.

Month.	Arrived.	Cleared.	Total.	Registered tonnage.
January	18	18	36	2,414
April	80	65	145	194,705
May	563	544	1,107	1,448,759
June	561	553	1,114	1,379,478
July	557	524	1,081	1,356,524
August	532	525	1,057	1,281,516
September	481	486	967	1,183,967
October	493	461	954	1,193,563
November	349	360	709	828,073
December	77	80	157	183,040
Total	3,711	3,616	7,327	9,002,039

Total tons cargo received through Duluth Canal	2,361,455
Total tons cargo departing through Duluth Canal	6,700,713
Total	9,062,168

Seven thousand four hundred and thirty-five tugs passed in and same number passed out of Duluth Canal with dump scows, besides many tugs, light or with vessels in tow, which are not included in total arrivals and departures.

Freight received and shipped, Duluth and Superior combined.

Items.		Price per unit.	Quantity.	Valuation.
Coal, hard	tons	$5.25	643,179	$3,376,690
Coal, soft	do	3.30	2,029,398	6,697,013
Limestone	do	1.80	39,956	71,921
Salt	barrels	.90	305,883	275,294
Machinery	tons	300.00	332	99,600
Manufactured iron	do	60.00	53,228	3,193,680
Kerosene oil	barrels	5.80	108,146	627,247
General merchandise	tons	100.00	233,881	23,388,100
Logs	feet B. M	11.00	75,142,000	826,562
Fish	tons	70,00	745	52,150
Cement	barrels	1.40	180,166	252,232
Building stone	tons	6.50	6,906	44,888
Sand and gravel	cubic yards	.50	30,141	15,070
Iron ore	tons	2.25	5,979,740	13,454,415
Copper	do	340.00	67,344	22,896,960
Flour	barrels	3.75	5,949,012	22,308,795
Wheat	bushels	.70	30,776,404	21,543,483
Grains	do	.70	12,960,154	9,072,108
Structural steel	tons	75.00	836	62,700
Wool	do	260.00	7,348	1,910,480
Lumber	M feet B. M	14.00	323,901	4,534,614
Lath	M number	2.00	30,567	61,134
Shingles	do	1.00	175,327	175,327
Stone	tons	.75	1,250	938
Ties	number	.30	559,318	167,795
Total		....	....	135,109,196

Commerce for the head of the lakes (Duluth, Minn., and Superior, Wis., combined) for the navigation season of 1900.

Receipts.	Tons.	Shipments.	Tons.
Anthracite coal	648,179	Iron ore	5,979,740
Bituminous coal	2,029,398	Copper	67,344
Building stone	6,906	Flour	594,901
Other stone	1,250	Wheat	923,292
Salt	43,697	Other grains	324,003
Machinery	832	Structural iron or steel	836
Manufactured iron	58,228	Wool	7,348
General merchandise	168,643	Merchandise	65,238
Lime and cement	75,989	Lumber	677,359
Kerosene oil	21,629		
Fish	745		
Sand and gravel	40,188		
Total	3,085,184	Total	8,640,061

Total tons cargo entered and departed	11,725,245
Valuation	$135,109,196
Total arrivals and departures	11,334
Registered tonnage	14,887,068

Arrivals and clearances of vessels at Superior, Wis., for two years.

Year.		Arrivals and clearances.	Average vessel tonnage.	Tonnage.
1899:				
Steam	3,345			
Sail	619			
		[a]3,964	[b]1,507	4,996,436
1900:				
Steam	3,308			
Sail	699			
		[a]4,007	[b]1,489	5,385,029
Increase (+) or decrease (−)		+43	−18	+388,593

[a] Does not include dump scows which passed in and out of Wisconsin Entry.
[b] Exclusive of tugs.

The storage capacity of the Superior elevators is 20,600,000 bushels.

Vessel report for Superior Harbor for season of 1900.

ENTERING.

	Boats.	Registered tonnage.	Tons of cargo.
Number which entered Superior Harbor via Duluth Canal	1,041	1,395,202	1,126,336
Number which entered Superior Harbor light via Duluth Canal	177	217,109	....
Number which came in Wisconsin Entry and discharged to Superior	189	269,182	[a]723,729
Number which entered Wisconsin Entry light or with rafts in tow	607	775,226	....
Total	2,014	2,656,719	1,850,065

DEPARTING.

Number which took cargo from Superior and departed through Duluth Canal	564	729,637	882,930
Number which left Superior light and departed through Duluth Canal	236	280,675	....
Number which loaded at Superior and departed through Wisconsin Entry	639	992,147	[b]1,939,348
Number which left Superior light and took cargo on at Duluth and departed via Duluth Canal	364	497,507	....
Number which departed through Wisconsin Entry light or with booms in tow	190	228,344	....
Total	[c]1,993	2,728,310	2,822,278

[a] These figures do not include 75,142,000 feet of logs towed in through the entry by tugs.
[b] These figures include 36,537 tons loaded at Duluth.
[c] These figures do not include tugs which passed in and out of the entry with dump scows or with vessels in tow.

Vessel report for Wisconsin Entry for season of 1900.

ENTERING.

	Boats.	Registered tonnage.	Tons of cargo.
Number which came through Wisconsin Entry and discharged at Superior	189	269,182	*a* 723,729
Number which came through Wisconsin Entry light or with rafts in tow	607	775,226	....

DEPARTING.

	Boats.	Registered tonnage.	Tons of cargo.
Number which took cargo at Superior and departed through Wisconsin Entry	639	992,147	*b* 1,939,348
Number which departed through Wisconsin Entry light or with booms in tow	190	228,344	....

a These figures do not include 75,142,000 feet of logs towed in through the entry by tugs.
b These figures include 36,587 tons loaded at Duluth.

Shipments and receipts by lake of leading articles during the season of 1900, Superior Harbor.

Shipments.	Tons.	Receipts.	Tons.
Wheat	424,684	Coal	1,714,291
Other grain	174,685	Cement and lime	14,846
Wool	6,370	Kerosene oil	20,571
Flour	289,912	Salt	12,370
Structural iron	....	Miscellaneous	64,477
Copper ore	51,066	Manufactured iron	23,510
Lumber, lath, etc	117,469		
Iron ore	1,709,311	Total	1,850,065
Merchandise	12,242		
		Total receipts and shipments	*a* 4,635,804
Total	2,785,739	Total value	$65,410,245

a Not including logs.

Passengers departing	1,199
Passengers arriving	822
Total	2,021

Valuations are based on average wholesale prices on board vessels for exports, and landed on wharves for imports.

Comparative statement of receipts and shipments for seventeen years.

Year.	Tons.	Year.	Tons.	Year.	Tons.
1884	17,462	1890	1,495,385	1896	2,995,067
1885	33,626	1891	1,616,648	1897	3,699,144
1886	117,027	1892	1,733,444	1898	4,194,443
1887	170,020	1893	1,918,350	1899	4,377,882
1888	327,327	1894	2,598,264	1900	4,635,804
1889	1,006,542	1895	2,577,281		

Detailed statement of arrivals and clearances of vessels, Superior, Wis., for season of 1900.

Month.	Arrived.	Cleared.	Total.	Registered tonnage.
April	32	44	76	128,269
May	321	322	643	859,351
June	329	318	647	807,763
July	303	304	607	782,276
August	289	271	560	704,172
September	245	249	494	657,405
October	281	279	560	737,532
November	183	183	366	600,408
December	31	23	54	107,853
Total	2,014	1,993	4,007	5,385,029

Average tonnage per vessel, exclusive of tugs, 1,489.

Of the number of vessels reported for 1900, there were 3,308 steam and 699 sailing vessels. The steamers were divided as follows: 2,698 freight propellers, 208 passenger and freight combined, and 402 tugs.

Comparative statement of arrivals and clearances of vessels for seventeen years.

Year.	Vessels.	Tonnage.	Year.	Vessels.	Tonnage.
1884	94	119,288	1893	1,909	2,571,917
1885	200	113,519	1894	2,000	2,829,968
1886	316	283,787	1895	3,418	4,042,992
1887	462	404,780	1896	3,525	4,684,257
1888	812	915,816	1897	3,529	4,841,392
1889	900	1,122,048	1898	3,962	5,337,230
1890	1,256	1,541,777	1899	3,964	4,996,436
1891	1,610	2,984,463	1900	4,007	5,385,029
1892	1,940	2,498,507			

NEW LINES OF TRANSPORTATION, DULUTH-SUPERIOR.

Port Huron and Duluth Steamship Company, 2 steamers.

Harlem Transportation Company, 1 steamer.

Pittsburg Steamship Company, 69 steamers, 43 barges; a combination of several lines under the management of Capt. A. B. Wolvin, Duluth, Minn., and owned by the United States Steel Company.

REMARKS.

DULUTH-SUPERIOR HARBOR.

Cargo received.—The number of tons cargo received through the Duluth Canal was 2,361,455, and through the Wisconsin Entry, 723,729 tons, not including logs; 75,142,000 feet B. M. of logs in rafts came through the Wisconsin Entry, of which amount 43,540,000 feet B. M. were discharged at Duluth, Minn.

Cargo departing.—The number of tons cargo departing through the Duluth Canal was 6,700,713 tons, and through the Wisconsin Entry, 1,939,348 tons. Of the latter amount 36,537 tons were loaded at Duluth, Minn.

Freight traffic.—The total freight traffic of 11,725,245 net tons shows an increase of 117,157 tons over 1899. Compared with 1899 there were nearly 23,000,000 bushels less of wheat and other grains, with a valuation of $18,169,964 less than in 1899. Anthracite coal shows a decrease of 328,557 tons, valued at $1,724,924. Iron ore shows an increase of 1,054,685 net tons.

Passengers.—The total number of passengers arriving and departing was 62,993, an increase of 6,723 over 1899 and 27,191 over 1895.

WISCONSIN ENTRY.

There was an increase of 543,555 net registered tons, and 949,004 tons cargo through the Entry over 1899.

Vessel tonnage: The net registered tonnage given was obtained from reports of each trip of each vessel entering or departing, and from marine registers.

Valuations of the various items of freight were obtained from the various trade journals, commercial records, and from the principal wholesale dealers, and are based on average wholesale prices on board vessels for exports and landed on wharves for imports.

The navigation season covered a period of 235 days from the first departure to the last arrival to and from the lower lakes.

REPORT OF MR. F. L. DEVER, ASSISTANT ENGINEER IN CHARGE OF DREDGING.

UNITED STATES ENGINEER OFFICE,
Duluth, Minn., July 2, 1901.

CAPTAIN: I have the honor to submit the following report of the dredging operations in my charge for improving the harbor at Duluth, Minn., and Superior, Wis., under the project authorized by act of June 3, 1896, and modified May 9, 1901, as carried on during the fiscal year ending June 30, 1901, together with a general résumé of the work and incidentals in connection therewith.

The work of dredging is carried on under two contracts (continuous) with Williams, Green & Williams and with Charles S. Barker for dredging some 26,400,000 cubic yards of material, more or less.

The contract with Williams, Green & Williams, of Duluth, Minn., is for dredging some 14,500,000 cubic yards of material, more or less, of which 6,200,000 cubic yards, more or less, is to be dredged out of Superior and Allouez bays and entrances to the harbor, constituting dredging district No. 1, at 7½ cents per cubic yard, scow measurement; 3,600,000 cubic yards, more or less, out of St. Louis Bay, between Duluth-Superior bridge and Northern Pacific Railway bridge at Grassy Point, constituting dredging district No. 2, at 8 cents per cubic yard, scow measurement; and 4,700,000 cubic yards, more or less, out of St. Louis Bay and the St. Louis River, lying between the Northern Pacific Railway bridge at Grassy Point and main channel of St. Louis River at south end of Spirit Lake, constituting dredging district No. 3, at 10 cents per cubic yard, scow measurement. Contract dated March 18, 1897, approved April 29, 1897; work begun under same June 1, 1897, and to be completed by November 1, 1903, for the removal of 26,000,000 cubic yards, and contingent upon appropriations being made; or to be completed by November 1, 1902, for the removal of 21,000,000 cubic yards, and contingent upon appropriations being made.

The contract with Charles S. Barker, of West Superior, Wis., is for dredging some 11,900,000 cubic yards of material, more or less, of which 7,600,000 cubic yards, more or less, is to be dredged out of district No. 1; 1,800,000 cubic yards, more or less, out of district No. 2; and 2,500,000 cubic yards, more or less, out of district No. 3, the districts covering the same territory and the prices for each district being the same as under the contract with Williams, Green & Williams. Contract dated March 18, 1897; approved May 8, 1897; work begun under same June 28, 1897, and to be completed by November 1, 1903, for the removal of 26,000,000 cubic yards, and contingent upon appropriations being made; or to be completed by November 1, 1902, for the removal of 21,000,000 cubic yards, and contingent upon appropriations being made.

Dredging operations have been continued during the past fiscal year under the former contract by E. T. Williams & Sons, and under the latter contract by Charles S. Barker to May 21, 1901, and by Rose Barker, special administratrix of the estate of Charles S. Barker, deceased, since May 21, 1901.

The total amount of material removed during the year under the two contracts was 3,867,095 cubic yards. Of this amount 1,428,198 cubic yards were dredged out of district No. 1, at 7½ cents, amounting to $107,129.85; 781,197 cubic yards out of district No. 2, at 8 cents, amounting to $62,495.76; and 1,657,700 cubic yards out of district No. 3, at 10 cents, amounting to $165,770, thus making a total of $335,380.62 earned under the contracts in the three districts during the fiscal year.

Under contract with Williams, Green & Williams, a total of 1,787,311 cubic yards were dredged, of which 601,083 cubic yards were dredged out of district No. 1, at 7½ cents, amounting to $45,081.23; 441,150 cubic yards out of district No. 2, at 8 cents, amounting to $35,292.00; and 745,078 cubic yards out of district No. 3, at 10 cents, amounting to $74,507.80, thus making a total of $154,881.02 earned under the contract in the three districts during the year.

Under contract with Charles S. Barker, a total of 2,079,784 cubic yards were dredged, of which 827,115 cubic yards were dredged out of district No. 1, at 7½ cents, amounting to $62,033,63; 340,047 cubic yards out of district No. 2, at 8 cents, amounting to $27,203.76; and 912,622 cubic yards out of district No. 3, at 10 cents, amounting $91,262.20, thus making a total of $180,499.59 earned under the contract during the year.

The total amount of material dredged under the two contracts to June 30, 1901, is 15,626,995 cubic yards, of which 7,102,533 cubic yards have been taken out under the contract with Williams, Green & Williams, and 8,524,462 cubic yards under the contract with Charles S. Barker.

On the basis of dredging 21,400,000 cubic yards under the two existing contracts, there remains 5,773,005 cubic yards, more or less, to be dredged, of which 2,222,084 cubic yards, more or less, is to come out of district No. 1; 925,208 cubic yards, more or less, out of district No. 2; and 2,625,713 cubic yards, more or less, out of district No. 3.

In accordance with the division of the work, made by the contractors, there remains 3,387,851 cubic yards, more or less, to be dredged under the contract with Williams, Green & Williams, and 2,385,154 cubic yards, more or less, under the contract with Charles S. Barker. Taking the capacity of the plant at present employed upon the work under contract with Williams, Green & Williams as a basis from which to estimate, the indications are that the contractors will fall short of removing the 3,387,857 cubic yards of material by November 1, 1902, by about 500,000 cubic yards; and taking the capacity of the plant at present employed upon the work under contract with Charles S. Barker as a basis from which to estimate, the indications are that the 2,385,154 cubic yards will be removed by June 30, 1902.

By terms of contracts, there is nothing to prevent a change in the relative amounts of work to be done under each contract, if it was found necessary to do so in order to complete the entire work by November 1, 1902.

The work during the past fiscal year was a continuation of the deepening and widening of existing channels and basins in Superior Bay, Allouez Bay, St. Louis Bay, entrances to harbor and dredging a new channel in the flats of the St. Louis River, in order to give a safe 20-foot navigation depth throughout the proposed channels and basins called for under the the project authorized by act of June 3, 1896, and the modified project, approved May 9, 1901.

Summary of amounts of material dredged under contracts with Williams, Green & Williams and Charles S. Barker in each district during fiscal year ending June 30, 1901, with totals:

Name of contractor.	District No. 1.	District No. 2.	District No. 3.	Total.
	Cu. yards.	*Cu. yards.*	*Cu. yards.*	*Cu. yards.*
Williams, Green & Williams	601,083	441,150	745,078	1,787,311
Charles S. Barker	827,115	840,047	912,622	2,079,784
Totals under the two contracts	1,428,198	781,197	1,657,700	3,867,095

Total amount of material dredged under the two contracts to June 30, 1901.

Name of contractor.	District No. 1.	District No. 2.	District No. 3.	Total.
	Cu. yards.	*Cu. yards.*	*Cu. yards.*	*Cu. yards.*
Williams, Green & Williams	3,513 580	2,795,505	793,448	7,102,533
Charles S. Barker	6,039,896	1,353,727	1,130,839	8,524,462
Totals under the two contracts	9,553,476	4,149,232	1,924,287	15,626,995

Summary of work under contracts with Williams, Green & Williams and Charles S. Barker, with estimated amounts of material remaining to be dredged under the modified project, approved May 9, 1901, and the totals for each district under the modified project.

Name of contractor.	Total amount dredged to June 30, 1901.	Estimated amount remaining to be dredged under modified project.	Total for modified project.
District No. 1:	*Cu. yards.*	*Cu. yards.*	*Cu. yards.*
Williams, Green & Williams	3,513,580	1,178,048	4,691,628
Charles S. Barker	6,039,896	1,044,036	7,083,932
Total	9,553,476	2,222,084	11,775,560
District No. 2:			
Williams, Green & Williams	2,795,505	284,579	3,080,084
Charles S. Barker	1,354,727	640,629	1,994,356
Total	4,149,232	925,208	5,074,440
District No. 3:			
Williams, Green & Williams	793,448	1,925,224	2,718,672
Charles S. Barker	1,130,839	700,489	1,831,328
Total	1,924,287	2,625,713	4,550,000
Total:			
Williams, Green & Williams	7,102,533	3,387,851	10,490,884
Charles S. Barker	8,524,462	2,385,154	10,909,616
Grand total	15,626,995	5,773,005	21,400,000

Amounts earned to June 30, 1901, in each district under the two contracts, and the amounts that will be earned on the removal of the 21,400,000 cubic yards, with totals.

	Williams, Green & Williams contract.		Charles S. Barker contract.		Total for entire work.
	Amount earned to June 30, 1901.	Amount that will be earned on completion of work.	Amount earned to June 30, 1901.	Amount that will be earned on completion of work.	
District No. 1	$263,518.50	$351,872.10	$452,992.20	$531,294.90	$883,167.00
District No. 2	223,640.40	246,406.72	108,378.16	159,548.48	405,955.20
District No. 3	79,344.80	271,867.20	113,083.90	183,132.80	455,000.00
Total	566,503.70	870,146.02	674,454.26	873,976.18	1,744,122.20

Progress of the dredging operations to June 30, 1901, under the present project are as follows:

Duluth ship canal deepened to 23 feet, or more, to within 45 feet of new piers for its entire length. Duluth Harbor basin deepened to 20 feet, or more, for a width of 1,350 feet on north side, extending from Duluth ship canal to entrance to Rices Point channel. Rices Point channel deepened to 20 feet, or more, for its full proposed bottom width of 600 feet, for 1,000 feet at northerly end, and a bottom width of 500 feet on remaining portion, with entrance to East Gate basin flared out somewhat. East Gate basin deepened to 20 feet, or more, for a distance of 1,375 feet easterly from Duluth-Superior bridge, at a point halfway between entrances of Rices Point channel and Superior Front channel, and gradually increasing to a distance of about 1,500 feet easterly from said bridge at entrance of said channels. West Gate basin deepened to 20 feet, or more, for a distance of 1,450 feet westerly from the Duluth-Superior bridge with approaches to drawspan of Northern Pacific Railway bridge deepened to 20 feet, or more. North channel, St. Louis Bay, deepened to 20 feet, or more, for a width of 450 feet at east end of bend west of Rices Point, increasing to a width of 600 feet at middle portion of bend at entrance to Twenty-first Avenue channel, and decreasing in width from the latter point to west end of said bend, where the width is 400 feet. This width extends to a point opposite Boston Coal Dock and Wharf Company's coal wharf, and from the latter point to Northern Pacific Railway bridge at Grassy Point it has been deepened to 20 feet, or more, for a width of 200 feet, or more. Minnesota channel, St. Louis River, deepened to 20 feet, or more, for its full proposed width from Northern Pacific Railway bridge at Grassy Point to a point near end of Grassy Point, and from latter point to a point near Spirit Island in Spirit Lake deepened to 20 feet, or more, for widths ranging from 40 feet to 200 feet. Twenty-first Avenue channel deepened to 20 feet, or more, for a width of 120 feet, extending its entire length. Superior entry deepened to 23 feet, or more, for a width of 220 feet extending from the natural 23 foot depth in lake to inner end of south pier, and from the latter point deepened to 20 feet, or more, and increasing to 650 feet in width at entrance to Superior Harbor basin. Shoaling has taken place near outer end of entry, so that there is barely 20 feet of water on north half about 150 feet inside outer end of piers. Superior Harbor basin deepened to 20 feet, or more, over an area of about 60 acres; the width of deepened portion being from 500 feet to 800 feet from entry through end of Wisconsin Point, and 260 feet to 500 feet along harbor line on westerly side of Allouez Bay. Shoaling has taken place in this basin, so there is but 18 feet of water available in places. Allouez Bay channel deepened to 20 feet, or more, for widths ranging from 275 feet to 375 feet, extending from Superior Harbor basin to east side of Chicago, St. Paul, Minneapolis and Omaha Railway wharf. Superior Front channel deepened to 20 feet, or more, for widths ranging from 300 feet to 400 feet; the narrower portions being in front of West Superior and Schofield lumber wharves, and extending 1,700 feet southeasterly from the latter wharf. Shoaling has taken place in the portion of this channel extending from the Youghiogheny and Lehigh coal wharf to Superior Harbor basin, so that there is but 17 feet of water available on the southerly half of this portion. This shoal is being removed at the present time. South channel, St. Louis Bay deepened to 20 feet, or more, for widths ranging from 375 feet to 400 feet, extending from Northern Pacific Railway bridge to a point opposite Youghiogheny coal wharf, and from the latter point to junction with North channel deepened to 20 feet, or more, for widths ranging from 50 feet to 125 feet.

Table showing combined amount of material dredged under the two contracts with Williams, Green & Williams and Charles S. Barker at each channel, or basin, during the fiscal year ending June 30, 1901, with totals to end of the fiscal year, and estimated amount remaining to be dredged to complete the work on basis of removing 21,400,000 cubic yards of material under the existing contracts.

Name of channel or basin.	Amount for year ending June 30, 1901.	Total to June 30, 1901.	Estimated amount remaining to be dredged.	Total for modified project.
District No. 1:	*Cubic yards.*	*Cubic yards.*	*Cubic yards.*	*Cubic yards.*
Duluth Ship Canal	61,852	69,452	5,000	74,452
Duluth Harbor Basin	205,771	1,064,503	1,170,548	2,235,051
Rices Point Channel	289,934	1,805,066	....	1,805,066
East Gate Basin	43,526	772,915	25,000	797,915
Superior Front Channel	718,953	3,632,567	266,189	3,898,756
Allouez Bay Channel	....	299,907	195,000	494,907
Superior Harbor Basin	113,162	1,698,435	535,347	2,233,782
Superior Entry	....	210,631	25,000	235,631
Total	1,428,198	9,553,476	2,222,084	11,775,560
District No. 2:				
West Gate Basin	....	933,148	25,000	958,148
North Channel, St. Louis Bay	441,150	1,998,210	259,579	2,257,789
South Channel, St. Louis Bay	340,047	1,035,776	640,629	1,676,405
Twenty-first Avenue Channel	....	182,098	....	182,098
Total	781,197	4,149,232	925,208	5,074,440
District No. 3:				
Minnesota Channel, St. Louis River	1,657,700	1,924,287	2,625,713	4,550,000
Grand total	3,867,095	15,626,995	5,773,005	21,400,000

Table showing the combined amounts of material dredged under the two contracts with Williams, Green & Williams and Charles S. Barker, at each channel or basin, and in each district, during each of the working seasons 1897, 1898, 1899, and 1900, with totals.

Name of channel or basin.	1897.	1898.	1899.	1900.	Total.
District No. 1:	*Cubic yards.*	*Cubic yards.*	*Cubic yards.*	*Cubic yards.*	*Cubic yards.*
Duluth Canal	....	....	7,600	....	7,600
Duluth Harbor Basin	62,421	330,482	451,145	49,844	893,892
Rice Point Channel	354,185	374,537	594,125	474,669	1,797,516
East Gate Basin	189,048	264,621	207,148	112,098	772,915
Superior Entry	123,365	42,714	44,552	....	210,631
Superior Harbor Basin	440,985	731,250	412,773	18,774	1,603,782
Allouez Bay Channel	....	77,897	222,010	....	299,907
Superior Front Channel	94,683	982,890	1,573,119	848,064	3,498,756
Total	1,264,687	2,804,391	3,512,472	1,503,449	9,084,999
District No. 2:					
West Gate Basin	196,326	501,728	235,094	....	933,148
North Channel, St. Louis Bay	149,382	523,622	589,383	595,402	1,857,789
South Channel, St. Louis Bay	....	348,897	204,964	392,544	946,405
Twenty-first Avenue Channel	....	....	182,098	....	182,098
Total	345,708	1,374,247	1,211,539	987,946	3,919,440
District No. 3:					
Minnesota Channel, St. Louis River	....	....	....	1,436,899	1,436,899
Grand total	1,610,395	4,178,638	4,724,011	3,028,294	14,441,338

Table showing summary of work under contract with Williams, Green & Williams for seasons of 1897, 1898, 1899, and 1900, with totals.

Time.	District No. 1.	District No. 2.	District No. 3.	Total.
	Cubic yards.	*Cubic yards.*	*Cubic yards.*	*Cubic yards.*
Season of 1897	563,977	345,708	....	909,685
Season of 1898	882,174	791,612	....	1,673,785
Season of 1899	1,190,805	922,362	....	2,113,167
Season of 1900	636,611	595,402	687,344	1,919,357
Grand total	3,273,567	2,655,084	687,344	6,615,995

Table showing summaries of work under the contract with Charles S. Barker for the seasons of 1897, 1898, 1899, and 1900, with totals.

Time.	District No. 1.	District No. 2.	District No. 3.	Total.
	Cubic yards.	*Cubic yards.*	*Cubic yards.*	*Cubic yards.*
Season of 1897	700,710	....	....	700,710
Season of 1898	1,922,217	582,635	....	2,504,852
Season of 1899	2,321,667	289,177	....	2,610,844
Season of 1900	866,838	392,544	749,555	2,008,937
Grand total	5,811,432	1,264,356	749,555	7,825,343

* * * * * * *

Dredging operations for the season of 1900 were suspended on November 15 as a result of severe cold weather and formation of ice in the harbor, and were resumed again for season of 1901 on April 20.

The minimum combined plant engaged upon the work at any one time during the active working season of the fiscal year consisted of 8 dipper dredges, 1 hydraulic dredge, 12 tugs, and 20 dump scows, while the maximum for a short time consisted of 10 dipper dredges, 1 hydraulic dredge, 14 tugs, and 24 dump scows.

The plant engaged upon the work, under contract with Williams, Green & Williams, at different times during the year, consisted of 7 dipper dredges, 8 tugs, and 15 dump scows. Four of the dredges were repaired and somewhat remodeled during the past winter. The hulls were strengthened by bracing, and truss rods and wire cables were substituted for the hoisting chains. These were first-class modern machines and well adapted to the work. One of these dredges was destroyed by fire on the morning of June 8, 1901. One of the dredges, a new machine throughout, did not appear upon the work until the last week in June. This is the largest and most modern dredge in the harbor, and it is believed she will do good work when the machinery is gotten properly adjusted and in smooth working condition. The other two dredges are old, with machinery badly worn and out of date, and can hardly pay running expenses at contract prices. Tugs are fairly well adapted to the work, and the greater portion of the scows are in good condition.

The plant engaged upon the work, under contract with Charles S. Barker, at different times during the year, consisted of 5 dipper dredges, 1 hydraulic dredge, 7 tugs, and 12 dump scows. The hydraulic dredge received a pair of new compound engines and some other minor repairs during the past winter, and is in good condition for the work expected of her. Three of the dipper dredges had cables substituted for the hoisting chains, one of them received new machinery throughout, and all of the dipper dredges had minor repairs and alterations made upon them during the past winter. They are at present in good condition and well adapted to the work. The tugs are well adapted to the work, and scows are in good condition.

* * * * * * *

During the year the inshore dumping ground at Duluth, in the lake, extended along the shore of Minnesota Point from the south pier of Duluth Ship Canal to a point 1½ miles southeasterly of same and inside a line between outer end of Duluth Canal and Superior Entry piers. The deep-water dumping ground extended from 1 mile to 1½ miles southeast of Duluth Canal in water of an original depth of 40 to 65 feet.

At the inshore dump the scows were run inshore as far as possible without grounding, or as close as possible to the preceding line of dumps, and then brought to a stop and dumped. Each load was placed systematically where designated by the inspector, who would indicate the exact spot where the scow was to be dumped by a buoy with a conspicuous flag on it. This system was carried out only in daylight.

Dumping at the deep-water dumping ground was done in rough weather, when the scows had to be towed astern, and all the dumping at night was at this dumping ground. The scows were dumped when running under check and the material scattered so as not to shoal up too fast at any one spot.

During the working season of 1900 there was a total of 2,836,878 cubic yards of material deposited at these dumping grounds from Government and private dredging in the harbor, of which 1,557,572 cubic yards were dumped at the inshore dump and 1,279,306 cubic yards at the deep-water dump. There was a total of 7,435 scow loads of material brought to these dumping grounds during the season, which would give 14,970 passages of tugs with dump scows through the Duluth Ship Canal. Of the total number of scow loads, 4,111 were dumped at the inshore dump and 3,324 scow loads at the deep-water dump.

The dumping ground for material passing through Superior Entry extended from

1 mile to 1½ miles northerly from outer end of Entry piers in water of an original depth of 63 to 75 feet.

During the season of 1900 the entire amount of dredged material from Government and private work passing through Superior Entry, being about 900,000 cubic yards, was disposed of at this dumping ground.

Of the total amount of material taken out by the dipper dredges under the Government contracts during the season of 1900, 2,796,270 cubic yards was disposed of at the lake dumping grounds, and an aggregate of 382,469 cubic yards was dumped inside harbor lines in Superior Bay, St. Louis Bay, and St. Louis River, of which 72,532 cubic yards were disposed of for filling wharves and other purposes.

The entire amount removed by the hydraulic dredge, 749,555 cubic yards, was deposited inside harbor lines adjacent to the work.

The dumping inspectors kept a record of each scow dumped in lake, with its number and time of dumping, and an estimate was made as to under or over load, leakage, and amount of material washed overboard, when it was possible to do so, for each scow load of material from the Government work. The estimates on the under and over load was used only as a check on the dredging inspector's estimate. Deductions were made for all leakages and for material washed overboard, as estimated by the dumping inspectors. There were no check estimates on the dredging inspector's estimate for the greater portion of the material disposed of inside harbor lines in the bays.

During the winter, November 26, 1900, to February 26, 1901, a total of 62,947 soundings were taken through the ice. These soundings covered 16.5 miles of channels and a portion of basins which are being improved under the present project, besides 9.5 miles of St. Louis River channel, extending from end of proposed Minnesota channel to foot of rapids, St. Louis Bay entire, and Lake Superior adjacent to Minnesota Point.

Specially designed chisels were used for cutting holes in ice for sounding in St. Louis River and in Lake Superior, and an ice-boring machine was used for boring holes for the remainder of soundings. The average thickness of ice for the winter's work was about 15 inches. This gives about 15 miles as the total thickness of ice cut through in taking the soundings.

The best day's record for the winter was 1,549 soundings through 18 inches of ice, the average depth of sounding being 21 feet.

Excluding the upper St. Louis River soundings, 3,194 in all, the average cost of field work per sounding was almost exactly 3 cents, which may be considered a very reasonable figure, taking into consideration the ground covered. The conditions of the ice and weather were very favorable for the work. The field party lost but half a day on account of severe cold or stormy weather, but there was a larger amount of time lost than usual on account of sickness, resulting mostly from exposure. This time lost amounted to about 8 per cent of the total time on the work. The soundings taken during the winter have been mapped. Those covering improved channels are detail sheets on scale of 100 feet to 1 inch or 200 feet to 1 inch, and those covering upper St. Louis River, St. Louis Bay entire, and Lake Superior adjacent to Minnesota Point, on a scale of 400 feet to 1 inch.

The soundings of the past winter show that a very marked shoaling has taken place in Superior Front channel and Superior Harbor Basin in vicinity of the mouth of Nemadji River. This shoaling amounts to as much as 5 feet in places, and it is estimated that the deposit from the Nemadji River in this locality has been 50,000 cubic yards or more during the past year. The shoalest spot found in Superior Front channel was near center of channel and had a depth of 16.7 feet at low-water depth. At this place the channel was dredged to a depth of about 22 feet in 1899.

A shoal was discovered in Superior Entry with a least depth of 19.9 feet at low-water depth. Shoaling has taken place the entire length of entry, but the greatest amount is about 150 feet in from outer end of piers and just north of center line. The shoaling at this point amounts to about 5 feet since this portion of entry was deepened in 1897.

There was an average shoaling of about three-tenths of a foot in the West Gate Basin. This shoaling was probably partly due to the dredging operations in progress in the channels above this basin.

There is but slight shoaling in other parts of the channels and basins in Superior Bay and St. Louis Bay, except at the sides of channels, where the high banks are running in and narrowing up the 20-foot depth of channels. At time of dredging channels the slopes on sides range from 1:1 in places to 3:1 in other places, depending on class of material. As shown by the action of banks of the channels in this harbor, dredged to 16 feet or more in past, it is believed that in course of five years' time the sides of deepened channels will take slopes ranging from 3:1 in places to 5:1 or more in other places.

As the dredging operations for improving the harbor at Duluth, Minn., and Superior, Wis., under the existing contracts will be completed by November 1, 1902, it would appear pertinent at this time to touch upon the expediency of the United States owning an efficient dredging plant to be operated in this harbor for maintaining a safe 20-foot navigation depth in the channels and basins for the full width and dimensions given the same under the present project. Upon the completion of the work under the existing contracts there will be about 16.5 miles of channels, ranging in width from 120 feet to 600 feet, and an approximate area of 250 acres in basins, all with a safe 20-foot navigation depth. These channels and basins will begin to deteriorate as soon as work is discontinued upon same from the caving and running in of the high banks at sides of channels, and from the material brought down the St. Louis River and Nemadji River at time of freshets and dropped in the channels and basins. It is believed that in the course of five years after work is discontinued on the channels that the running in of high banks at sides of channels will result in decreasing the widths of the 20-foot depth by from 20 feet to 50 feet, depending on class of material at sides of channel, and that as a result of freshets shoals will be formed near the mouth of Nemadji River and at places in St. Louis River which would completely block a vessel drawing more than 12 feet of water.

It is estimated that to maintain the channels and basins in the harbor for a period of five years from the time work is discontinued on same under the present contracts, so as to give a safe 20-foot navigation depth at all times for the full widths and dimensions given them under the present project, would require the removal of 2,250,000 cubic yards of material, or an average of 450,000 cubic yards a dredging season. Of the total, it is estimated that 1,500,000 cubic yards would have to be removed as a result of the running in of banks at sides of channels, and that 750,000 cubic yards would have to be removed as a result of shoaling from freshets and other causes.

Owing to the large territory to be covered and the nature of the work, it is believed that this work can not be done under contract for less than 15 cents per cubic yard, and may possibly cost as much as 20 cents a yard under certain conditions. At 15 cents per cubic yard it would cost $67,500 a year, or $337,500 for a period of five years, for maintenance of channels and basins in the harbor, exclusive of superintendence, surveys, office expenses, etc.

If the United States owned a dredging plant, it is estimated that this work could be done for 7½ cents per cubic yard or less, including all operating expenses and maintenance of dredging plant, but excluding superintendence, surveys, office expenses, etc., which would amount to $33,750 a year, or $168,750 for a period of five years, for the maintenance of the channels and basins in the harbor. This would result in a saving to the United States of $33,750 a year, or $168,750 for a period of five years. The mere fact of such ownership would exert a conservative influence on the bids received for Government dredging in this district, and would doubtless result in the United States securing much more favorable contracts. Its most important advantage, however, would be to meet sudden emergencies, which will arise in even the best regulated system of works. With such a plant the United States would not be handicapped as a result of excessive prices that might be bid in case of extreme emergencies or the delays incident to advertising, making contracts, etc. Upon demand the plant could be promptly moved to the field of action without any previous dealings or arrangement with contractors. The plant should consist of 1 dipper dredge, capable of handling 4,500 cubic yards of sand in a day of 16 hours, working in a bank of 8 to 10 feet depth, and leaving 25 feet of water at stern of dredge, 1 powerful tug, 1 small tug, 3 dump scows, with a capacity of 500 cubic yards or more each, and 1 flat scow.

The cost of such a plant is estimated at $130,000, and with 10 per cent added for superintendence and inspection of the building of same, would make the total $143,000.

A cost of $40,000 a year for maintenance of the channels and basins in the harbor would be equivalent to but 3/10,000 of the valuation of the total receipts and shipments during the season of 1900, or a little over 34/100 of a cent per ton for the total amount of freight received and shipped.

Surveys were made during the year for locating shore line on east side of Minnesota and Wisconsin Points, the west side of Superior Bay, and the south side of St. Louis Bay; also to locate recent improvements on the water fronts of Allouez Bay, Superior Bay, and St. Louis Bay.

A new map of the harbor at Duluth, Minn., and Superior, Wis., including the St. Louis River to the foot of the rapids, on scale of 1,000 feet to 1 inch, was prepared during the past winter at a cost of about $2,000, of which about $700 was for field work, exclusive of the data obtained in connection with the harbor improvements, and about $1,300 was for office work on originals and tracing of same.

The map on tracing was forwarded to the Chief of Engineers, United States Army, on March 1, 1901.

The dredging operations and disposition of the dredged material have been under a thoroughly organized, systematized, and effective system of inspection.

When the entire plants were employed on the work, the inspection, supervision, and direction of the dredging and dumping of the dredged material was maintained by a force consisting of 1 assistant engineer, 16 inspectors, and 14 subinspectors.

These inspectors and subinspectors, with but few exceptions, have performed the various duties assigned them with ability, industry, and fidelity, especial mention being made of the ability, zeal, and fidelity with which Mr. H. H. Wadsworth, assistant engineer, and Mr. G. A. Taylor, inspector, have performed their duties, the latter as chief inspector on Duluth side and the former acting as chief inspector on Superior side; also as to the ability, industry, and fidelity with which Messrs. H. C. Bellinger and Edward H. Foster performed their duties as dumping inspectors on Duluth side, and with which Messrs Charles Carisch and Edward E. Bratton performed their duties as dumping inspectors on Superior side.

Respectfully submitted.

F. L. Dever,
Assistant Engineer in Charge of Dredging.

Capt. D. D. Gaillard,
Corps of Engineers, U. S. A.

REPORT OF MR. J. H. DARLING, ASSISTANT ENGINEER.

Duluth, *July 2, 1901.*

Captain: I have the honor to submit the following statement of work on the substructure of the new piers for the Duluth ship canal, and certain miscellaneous work relating to the canal, during the fiscal year ending June 30, 1901.

NORTH PIER SUBSTRUCTURE.

Placing cribs.—On the Butler-Ryan Company contract for building the substructure to the north pier, the last 11 cribs were sunk and filled, of which 10 were 24 feet wide and 100 feet long, for the main pier, and one was the pierhead crib, 24 to 36 feet wide, 100 feet long, and provided with a cutwater. The first of these 11 cribs was placed July 20, 1900, and the last one on December 12, 1900. The time required for sinking the entire number of 17 cribs for the north pier was 13 months. The contractors, and the Government also, have been fortunate in escaping loss or serious damage to any of the cribs after they were sunk, from storms or collisions or currents, and none of the cribs have suffered movement from their position as placed. The contractors worked night and day on ballasting cribs for about three months, from August 23 to November 14, 1900, using electric arc lights for seeing by.

Pumping gravel from the scow into cribs was allowed a trial first on July 3, 1900, into crib No. 12. An examination with an iron shod pole showed less spreading of the gravel than was expected, none passed over the walls to the outside of the crib, and it went down into the rock (which forms the main portion of the filling) better than when thrown in by shovels. This allowed more rock to be put into the crib at one time, and facilitated the ballasting by requiring fewer shifts from rock scow to gravel scow. There was thus put in a whole load of rock of about 300 tons at once, instead of about 110 tons, as was required by the old way. This pumping was continued thereafter, and would have affected a material saving in cost to the contractors but for the fact of imperfect machinery and frequent breakdowns.

Laying deck.—Deck timbers were laid on the easterly 13 cribs during the year, from July 30, 1900, to February 16, 1901. These timbers, which are from 6 to 12 inches thick, rest upon bulkheads 2 feet below low-water datum, and as the stage of water was from +2 feet high in October, 1900, to +1 foot in January, 1901, the deck crew had to work in 3 or 4 feet of water, wearing wading pants. The high water, currents, and the roiliness of the water made this operation a difficult one during the summer season and fall. Previous to August 12 the water was clear enough for about half the time each day to see to lay deck. Then for three months the water was entirely opaque, and the men had to fit the timbers by the sense of feeling. The inspection of it was also no easy task. This work proceeded slowly under these conditions, but the men kept at it with commendable patience. In the winter the water cleared up and lowered in stage, so that the final portion of this was easier and more satisfactory.

CONNECTION BETWEEN CRIBS OF NORTH PIER SUBSTRUCTURE BY GUIDE TIMBERS, KEY, AND STEEL PLATE LAP.

THE CRIBS ARE HERE PLACED APART FOR DISTINCTNESS.

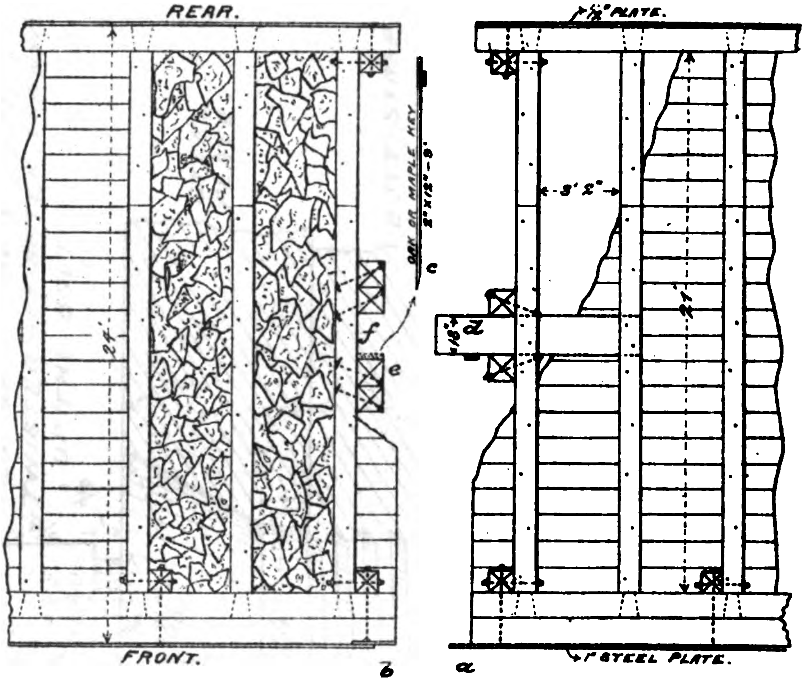

FIG. 1, PLAN.

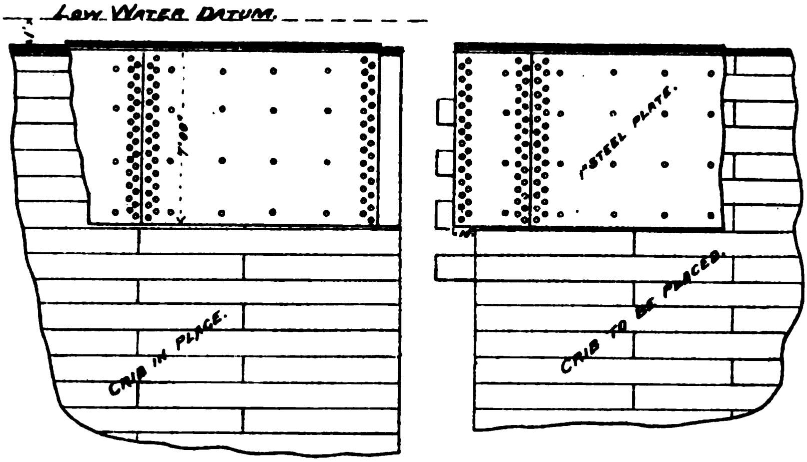

FIG. 2, ELEVATION.

Eng 57 1

THE NORRIS PETERS CO. PHOTO-LITHO. WASHINGTON D.C.

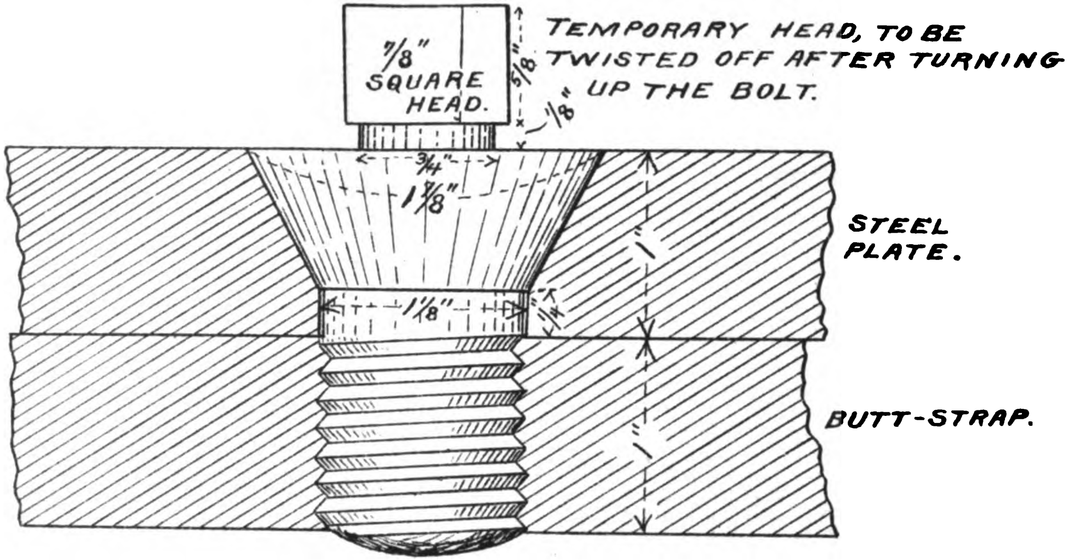

FIG. 2½, FULL SIZE.

PATCH BOLT USED FOR CONNECTING STEEL PLATES AT CRIB JOINTS, UNDER WATER, ALSO FOR CONNECTING 50-FOOT SECTIONS OF PLATE, AT MIDDLE OF 100-FOOT CRIBS, AT THE YARD, FOR SUBSTRUCTURE OF NORTH PIER.

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Submarine patch bolting.—The 1-inch steel plates, which form a protection to the channel face of the cribs for the upper 7 feet of their height, overlap from each crib to the preceding crib to a distance of 10 inches, and the lap lies in front of a butt strap, which is of 1-inch plate rivetted to the main plate of the crib. The 10-inch lap is punched and countersunk at the shop for 28 patch bolts, and these patch bolts are inserted under water by a diver, with pneumatic and other tools, it being necessary to drill and tap the butt strap. Figures 1 and 2 show arrangement of plates and guides. The 10-inch projection of 1-inch plate *a* overlaps the preceding crib at *b*, and is forced up to a close bearing by means of the hard-wood key *c* driven between the horizontal guide spuds *d* and the vertical guide post *e*, just after the right hand crib is brought up to the preceding crib and before it is weighted down with ballast. The space *f* between the guide posts is made 2 inches wider than the spuds to allow the latter to enter readily and give room for the key. This method of joining cribs under water worked well. The rear plates of lighter steel are not lapped, being designed only to resist the wear of ice and drift.

The plant used for patch bolting consisted of a derrick, upright boiler, hoisting engine, an engine for running an air compressor, compressor air-tank, 2 pneumatic tools, 15 drills, 10 taps, emery wheel, diving pump and headlight, all mounted on a scow 100 by 26 by $6\frac{1}{2}$ feet; and a steel cage for diver to work in, hung on the crib by two strong hooks, provided with a counterbalanced drill rest, and the lower end of the cage provided with two lag screws for holding it to the crib.

Crew consisted of 4 divers, 2 engineers, 2 divers' tenders, 4 pump men, 1 foreman, 1 watchman to look after lights at night. This work was prosecuted day and night. A $1\frac{1}{32}$-inch drill was used, and the hole tapped for a $1\frac{1}{8}$-inch patch bolt. The pneumatic tool does the drilling, cutting a continuous shaving from $\frac{1}{100}$ to $\frac{1}{80}$ inch in thickness. The work was done in cold weather, January and February 1901, and at first the moisture or water inside the tool would freeze and stop the drill, supposed to be due to the coolness produced by the expansion of the compressed air. Afterwards the air was passed through a coil of gas pipe over a furnace between the tank and drill which heated the air and obviated the trouble. The four divers worked in six-hour shifts, making twenty-four hours between them, per day. Each usually came up once for about ten minutes during the six hours. Their legs were apt to get cold, on account of the pressure of water and consequent lack of circulation, as they did not move about much in the cage. Tapping was done by hand, as the air tool did not have power enough for that. For tapping and for turning up the patch bolts and for twisting off the temporary head, a heavy ratchet was used, worked by a lever above water connected by a vertical rod with the ratchet.

Sixteen of these connections were made between January 7 and February 11, 1901, and this difficult work was well done. It was examined as the work progressed by the United States inspector, Mr. A. A. Sinclair, who used the contractor's diving suit for that purpose. The water was clear during this work, which added much to the facility and accuracy of the divers' operations.

Protection piles.—Pile clusters were built at points in the channel 35 feet from the new pier site, as a protection to the work from vessels. Twenty-four of these clusters were built during the year, and most of these were to replace clusters previously built and broken out by vessels and scows. These were in a row, with intervals of 50 feet. Each cluster consisted of 5 piles, standing in 25 to 30 feet of water, the bottoms spread apart and the tops bound together with wire rope. They could not resist the blow of a heavy vessel or scow, but served a useful purpose as a warning.

Sign boards were placed, one at each entrance to the canal, bearing the inscription: "Vessels must slow down according to law. Penalty $500," in plain letters on boards 6 by 8 feet in size.

Gauge well.—A well or pit was built into the pierhead crib so as to fall inside the north gallery, where it is intended to set up a self-recording water gauge. This well is made water-tight by caulking, and connected with the lake by a wooden pipe leading to the north, or lake side, of the pier, so as to show the true level of the lake surface.

Heretofore and at present the gauge readings at the head of Lake Superior have been taken inside the harbor, and show the stage of Superior Bay, which is affected by river discharge at times of high water in the latter, and never shows, except in part, the temporary or short period fluctuations of the lake on account of the time required for the bay to fill or empty through the entrance canals. A lake gauge is desired (a) for use in reducing correctly lake soundings, (b) for transferring the datum plane to other harbors or points on the lake, (c) for determining earth movements, or tilting of the land, by means of long-extended comparisons of gauges situated at opposite extremities of the lake, by methods similar to those outlined in Prof. G. K. Gilbert's paper on this subject in the Eighteenth Annual Report of the United

States Geological Survey, 1896-97, (d) for recording and studying fluctuations arising from winds, varying atmospheric pressure, tides, etc.

The size of the gauge well is 3 feet 2 inches by 6 feet 9 inches in plan, giving a liberal area of water surface in which to place the float; depth, 7 feet below low-water datum. The inlet is about 6 feet below datum, consisting of a horizontal wooden box 13 feet long, interior size 6 by 6 inches, and provided with a 3-inch brass gate valve at inner end, just inside the well. This valve will be operated by a rod running up into the gallery, and is designed to control the flow of water in and out of the well and specially to reduce the effect of waves, while at the same time providing sufficient flow to allow the water in the well to follow the lake oscillations. The rate of rise or fall of water in the well has been computed[1] for various heads and for different openings of the valve. The proper opening for the valve can be best determined by trial.

The contract work of building substructure was completed February 16, 1901. This was more than two months in advance of the extended time—May 1—allowed for completion. The original time for completion under the contract was December 1, 1900, but the difficulty of laying deck in the deep and roily water of the summer months, and the consequent slow progress, and the difficulty of patch bolting in opaque water, made it necessary to prolong the work into the following winter.

Removal of outer protection pier.—This was a temporary pier of crib work, ballasted with beach gravel, which was built in the spring of 1898 and placed in the lake in front of the site for the new south pier for a protection to the latter while under construction from storms and vessels, for carrying lights, and for use as a base or station for the instrumental work of triangulation and levels pertaining to the construction. This pier was in form of an angle, with vertex toward lake, 53 feet long on outside of each wing, 37 feet on inside, 16 feet wide over wing, and 26 feet deep. It stood about 5 feet above low-water datum. It served its purpose well, and in September and October, 1900, was moved to the north side of the canal to serve a similar purpose in the construction of the new north pier.

While the contractors were attempting to remove it, it was much damaged on October 1 by a northeast storm which caught them after the crib was emptied of gravel and before they had raised it from its original position. The storm pounded it on its foundation of riprap, which resulted in wearing away the bottom, up to and including a large part of the floor; also spread apart the two wings, opening the walls at inner angles. It was towed into the harbor where the contractors put a false floor in some of the pockets, closed opening in angle, and strengthened the upper portion to some extent by additional timbers. On October 12 it was placed in new position on a foundation of riprap, filled with rock and sand, and covered. On October 29 a northeast storm, accompanied by an unusually high sea, broke up this pier and carried it away. One wing stranded north of the canal. This loss probably would not have occurred but for the damage from the previous storm.

The foregoing work was under the inspection of Mr. A. A. Sinclair, chief inspector, who discharged his duties in a most creditable manner. Mr. Sinclair was assisted by J. L. Cromwell, inspector at the yard, and by Mr. E. K. Coe, inspector at canal, and by J. B. Wanless, diver, who inspected the submarine foundation work, each of whom proved capable and reliable.

Riprap.—A riprap protection is being placed along the base of the pier, under contract with Whitney Bros., dated May 14, 1901, and in accordance with plans and specifications prepared under your directions.

A portion of the riprap will be placed along the channel base of the pier to form a bottom revetment which will reach about 3 feet above the bottom of the cribs, and will leave about 19 feet of water over it at low water.[2]

The greater part of the riprap to be furnished will be placed at the rear side of the north pier and will lie upon an embankment of sand which is being formed from harbor dredgings and which will be held from running into the channel by a toe wall of riprap running northerly from the east end of the pier. This rear embankment of sand and rock will reach about 14 feet up the side of the cribs and within 8 feet of low water, and will serve to stiffen the pier and prevent undue vibrations. The riprap is of granite and the portion at rear of pier will consist of pieces 50 cubic feet in size and under.

The amount placed up to June 30, 1901, is 1,078½ tons, and the total contract amount is to be about 9,000 tons. Quantity is determined by water displacement of the rock scows.

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[1] Computation is in manuscript, made in February, 1900, for purpose of determining best size for the various parts.

[2] Some riprap will also be placed under this contract along the base of the westerly portion of the south pier.

COST OF NORTH PIER SUBSTRUCTURE.

The following items of cost cover the period from the time of beginning work on May 1, 1899, to June 30, 1901:

Butler-Ryan Company contract.—The tabulated figures herewith afford a comparison of quantities of material used, with the original estimate of same. Table 1 gives the original estimate of quantities, together with cost of same at contract prices made up and added after the bids were opened. Table 2 gives the actual quantities, or work done, at the contract prices named in Table 1, and is exclusive of extra work. Table 3 shows the increase or decrease of actual work over the estimated figures by comparing Tables 1 and 2.

TABLE 1.—*Original estimate of quantities and cost of same at contract prices.*

20,000 yards dredging, at 20 cents	$4,000.00
25,000 feet B. M. pine or fir in accessory works, at $20	500.00
15,000 linear feet round piling in accessory works, at 11 cents	1,650.00
3,400 pounds machine bolts in accessory works, at 2¼ cents	76.50
1,800 pounds cast or wrought washers in accessory works, at 1¼ cents	22.50
1,800 linear feet wire rope, at 18 cents	324.00
32,000 tons rock, at 83 cents	26,560.00
7,000 yards gravel, at 60 cents	4,200.00
100 hours' use of dipper-dredge plant, at $15	1,500.00
150 hours' use of pile-driver plant, at $5	750.00
1,722 linear feet of canal-pier cribs, including patch bolting, the contractor's bid for which was $500	121,250.00
Total	160,833.00

TABLE 2.—*Work actually done by Butler-Ryan Company at contract prices.*

18,147 yards dredging, at 20 cents	$3,629.40
32,852 feet B. M. pine in accessory works, at $20	657.04
18,460 linear feet round piling in accessory works, at 11 cents	2,030.60
4,080.3 pounds machine bolts in accessory works, at 2¼ cents	91.80
2,179.2 pounds cast washers in accessory works, at 1¼ cents	27.23
1,841.4 linear feet wire rope, at 18 cents	331.45
38,548.6 tons of rock, at 83 cents	31,995.32
8,400 yards gravel, at 60 cents	5,040.00
261⅚ hours' use of pile driver, at $5	1,309.17
1,722 linear feet of canal-pier cribs, including patch bolting, the contractor's bid for which was $500	121,250.00
Compensation for early completion	2,220.00
Total	168,582.01

TABLE 3.—*Increase or decrease of actual cost over the estimated cost in Table 1.*

		Increase.		Decrease.	
		Quantity.	Amount.	Quantity.	Amount.
Dredging	yards			1,853	$370.60
Pine timber	B. M.	7,852	$157.04		
Round piling	linear feet	3,460	380.60		
Machine bolts	pounds	680.3	15.30		
Washers	do	379.2	4.73		
Wire rope	linear feet	41.4	7.45		
Rock	tons	6,548.6	5,435.32		
Gravel	yards	1,400	840.00		
Pile-driver plant	hours	111.83	559.17		
Dredging plant, time work	do			100	1,500.00
Early completion	days	74	2,220.00		
Total			9,619.61		1,870.60
Net increase			7,749.01		

Referring to the items, it is seen that the largest increase is in the quantity of rock. This increase went between the bearing piles under the cribs and in the riprap embankment sloping away from the bearing piles, and was required on account of a deepening of the bottom along the site of the new pier by the scouring action of currents, which occurred between the date of the soundings (February, 1897) which were used in making the estimates and the time of preparing the foundations (1899 and 1900). The observed deepening, as shown by profiles and cross sections on file in this office, would require an additional 6,600 tons, which at 83 cents equals $5,478, and this almost exactly accounts for the increase noted in Table 3. The increase in timber,[1] bolts,[1] piling (in part),[1] is owing to additional temporary scaffolding from which to lay out the work, rendered necessary by the unexpected occupancy of the old north pier for the storage of concrete footing blocks, and for the replacing of scaffolding destroyed by storms and ice. The increase in wire rope[1] and piling (in part)[1] is owing to the great breakage of pile clusters by vessels, and their replacement. The item of compensation for early completion of the work, at $30 per day for time gained, was not included in the original estimate, although provided for in the contract. The principal item of decrease is that of time work with the dredging plant, which was estimated for in case of meeting hard digging in riprap, or in tearing out the west end of the old north pier. No riprap was met that did not excavate easily, and count as yardage. The old pier removed was partially taken to pieces by the contractors to save the material, and the remainder presented no obstacle to the dredge, as this portion of the pier rested on short piles. The net increase, $7,749, is 4.8 per cent of estimate in Table 1.

TABLE 4.—*Additional work pertaining to the north pier substructure, but outside of the Butler-Ryan Company contract.*

1899–1900. Building scaffold for laying out work, by Butler-Ryan Company	$2,074.57
1899–1900. Building pile clusters for protection from vessels, by Butler-Ryan Company	1,899.80
1900. Building transit stations, by Butler-Ryan Company	93.79
1900. Building templates for laying deck, by Butler-Ryan Company	96.19
May, 1900. Building test block for observing durability of iron bolts, by Butler-Ryan Company	22.22
May, 1900. Building water-gauge well in pier-head crib, by Butler-Ryan Company	70.64
May, 1899. Anchoring old north pier to prevent sliding toward new pier, by Butler-Ryan Company	65.67
June–December, 1900. Riprapping around Singer's tug office to protect from Government operations, by Butler-Ryan Company	47.85
October, 1900. Riprap for outer protection pier, by Butler–Ryan Company	144.00
1899–1901. Miscellaneous additional work, the items of which are given in the current monthly estimates, by Butler-Ryan Company	282.16
October, 1900. Removing outer protection pier from south pier to north pier, by Duluth Dredge and Dock Company	2,158.75
April, 1901. Building dam of riprap across trench, between old and new north pier, by Charles Stone	193.29
April, 1901. Altering position of inlet and screen to gauge well in pierhead, by J. B. Wanless	40.00
April, 1901. Removing scaffold, etc., and storing material, by Whitney Brothers	100.00
June, 1901. Driving 5 piles to protect haulage trestle from dumping scows, by Whitney Brothers	15.00
June, 1901. Placing riprap at base of pier, by Whitney Brothers, under contract dated April 5, 1901, and not yet completed	1,078.50
1899–1900. Driving cluster and scaffold piles, by Whitney Brothers	873.05
May, 1900. Material for gauge well, by Marshall-Wells Hardware Company	28.30
Total	9,283.78

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[1] The contract with Butler-Ryan Company provided that the quantities at contract prices were not to exceed or fall below the estimated amounts by more than 20 per cent of the latter. For the items here noted the 20 per cent was exceeded, and for the reason stated. Such excess was furnished by Butler-Ryan Company as extra work at actual cost plus 15 per cent, and appears in Table 4. Table 4 also contains additional work by other parties, under open-market purchase or under contract, as occasion demanded.

Summary of cost of north pier substructure.

Contract work, by Butler-Ryan Company	$168,582.01
Additional work, to June 30, 1901	9,283.78
Total work done	177,865.79
Inspection and incidentals	16,304.90
Operating plant	337.00
Cost of north pier substructure to June 30, 1901	194,507.69

The "additional work" is 5.5 per cent of the contract work; the inspection and incidentals 9.7 per cent of the contract work, or 9.2 per cent of the total work done; operating plant 0.2[1] per cent of the contract work. All of these several contingencies amount to 15.4 per cent of the contract work.

Further work remains to be done in the way of back filling and riprapping the substructure, the latter of which is now in progress.

SOUTH PIER SUBSTRUCTURE.

Since the completion of the main contract for the construction of the substructure of the new south pier on April 17, 1900,[2] the following additional work has been done:

Riprap embankment.—An embankment was built at the sides of this pier of rock dredged up from the old south pier in the operation of removing the latter, in November and December, 1900. This embankment was carried up to the water surface, from the east or lake end to a distance of 325 feet along the channel side, and a distance of 400 feet from east end along the south or rear side, and to a less height farther west on south side. The rear embankment was necessary to prevent undue vibration which was unexpectedly found to occur during storms, owing to the elasticity of the timber cribs and the rigidity of the concrete, and which caused some flaking of the concrete at the joints between the monoliths. The embankment along the channel face was considered necessary as an additional protection against collisions from vessels.

The rock forming this embankment was rather small in size, about one and two man, with a few larger pieces, mostly granite; has since been beaten down by storms 6 to 10 feet on channel side, most around the pierhead, and but little on south side at a distance of 100 feet or more from east end.

Removel of inner protection pier.—This was a temporary crib 16 feet wide, 18½ to 22½ deep, of which 6 feet was above water, and about 60 feet long, built in August, 1899, to close up the space between the old pier and the new at a point about 400 feet from the east end of the latter, to shut off storms from the area between the two piers just mentioned and thus afford protection to the work on the new pier in progress. Was built with a close bottom, filled with beach gravel ballast, and decked over (Sheet XLI of plans in office). It kept its position, retained its ballast, suffered no injury from storms, and served its purpose well.

It was intended to shift this pier, after it was no longer needed in its original position, to the north side of the canal to afford similar protection to the work on the new north pier, and in December, 1900, an attempt was made to do this. But it was found to be impossible without greater cost than the expected benefit would warrant and instead was towed into the lake, after pumping out most of the gravel, and beached at a point 1,800 feet south of the canal and 1,100 feet from shore, in 17 feet of water. It has since been driven by storms farther inshore.

Washout.—An undercut, caused by currents effecting an entrance under the crib, was discovered October 9, 1900, at station 12 (1,200 feet from east end of pier). The water washed out the sand among the rubble filling between the bearing piles to a depth of 1½ to 3 feet and 10 feet wide, letting the rubble down to the bottom of this trench. It is supposed that there was a deficiency in rubble under the pier at that point, and a small opening through which currents were forced by a difference in head of water on the opposite sides of the pier as would be produced by waves during storms, and to a less extent at times of strong currents in the canal. To close this breach sand was pumped from the channel over behind the pier, forming a bank about 11 feet high, and this has since remained. This caused no injury or settlement to the pier, the piles being too deep to be affected. No other instance of this kind has been observed.

Connection plates.—The steel-plate protection, 1 inch thick, which covers the upper 7 feet in height of the cribs, was connected up at the crib joints during last winter, February 15 to March 11, by Butler-Ryan Company under a special agreement, this work not having been included in the King & Steele contract for building the south pier substructure. The work consisted in securing connection plates 1 inch by 2 feet by 7 feet by submarine patch bolting to 1-inch butt straps, which were built in with the main plates, so as to form a recess for the connection plates of the size stated. These plates were punched and countersunk for 28 patch bolts 1¼ inch diameter, 14 in each side, and the drilling, tapping, and turning up was done by the same plant as was used on the north pier cribs, already described. The plans for crib connections were different for the two piers, as will be noticed, that for the north pier, which was designed later, being much the better.[1]

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[1] Taken same as south pier, Chief of Engineers Report, 1900, p. 3569.

[2] Plans in part were published in the Chief of Engineers Report for 1898, p. 2226, pls. 4, 5, 6.

The connections at the three most easterly joints of south pier were necessarily omitted on account of the presence of the riprap embankment, but may be supplied later, as the material is on hand, in case this embankment should be lowered enough by storms or otherwise. The plates for this work were supplied by Marshall-Wells Hardware Company, and each was made to size and shape to fit its recess from measurements taken by a diver after the cribs were sunk.

Removal of dike.—The dike of close piles, built in 1898–99 in lake, south of pier, and extending from the shore out to crib No. 5, to protect the work of pier construction, was removed in November, 1900, after it had served its purpose and was no longer needed.

The cost of the foregoing work relating to the south pier substructure is given in Table 5.

TABLE 5.—*Cost of accessory work, south pier substructure, for year ending June 30, 1901.*

November–December, 1900, riprapping around outer end, by Duluth Dredge and Dock Company	$3,920.22
December, 1900, pumping sand over the above riprap, by Osborn & Co.	510.00
December, 1900, moving inner protection pier to lake by Maytham's Towing and Wrecking Company	105.00
December, 1900, removing gravel from inner protection pier, by Osborn & Co	628.33
November, 1900, removing old pile dike, located south of new south pier, by Whitney Brothers	500.00
December, 1900, removing inner protection pier, by Duluth Dredge and Dock Company	297.08
February–March, 1901, placing connecting plates at joints, by Butler-Ryan Company	1,910.92
February–March, 1901, connection plates and patch bolts furnished by Marshall-Wells Hardware Company	450.00
Total	8,321.55
Inspection, incidentals, etc., approximately 9 per cent	748.94
Total for year ending June 30, 1901	9,070.49
Previous cost (Chart of Engineer's Report for 1900, p. 3569)	192,490.90
Total cost to June 30, 1901	201,561.39

MISCELLANEOUS WORK.

The following is work done at the Duluth Canal aside from pier construction, during the fiscal year ending June 30, 1901:

Removal of old pier.—The old south pier was dredged out in November and December, 1900, by the Duluth Dredge and Dock Company. This pier was about 1,200 feet long, of timber cribs and superstructure filled with rock, and having riprap at its base. The machine was a strong dipper dredge and tore out the pier without special difficulty. The timber, of white and Norway pine, which was below water, was entirely sound, and floated. The old timber was sound also up to and from 1 to 1½ feet above low-water datum, or from about one-half foot to 1 foot above the average stage of water, indicating the approximate level where decay begins to take place. The driftbolts, of 1⅛ inches square iron, were almost free from rust, after being in the water probably twenty-eight years. Some corrosion had occurred near seams between timbers, amounting to possibly 1 per cent of the cross section of the bolt, while the portion which was well inside the body of the timber seemed to be entirely free from corrosion and bright in color. This is a promising indication for the durability of the steel fastenings of the new pier cribs. Some close driven round Norway pine piles, which closed a breach in the pier made by a storm in 1896, driven in rubble and gravel, were found to be destroyed in great part by the driving. Some of them broomed up next to the cast-iron point, forcing the iron straps apart, and some piles crushed several feet up from the point and not elsewhere. These piles were driven hard, to effect the desired penetration, too hard as it now appears. On November 9 the old outer light tower was pulled over into the channel by the light-house engineers and towed into the lake and abandoned. Later in the same month the rear range-light tower was taken apart and transferred to the south pier of the Wisconsin entrance.

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[1] Figs. 1 and 2.

The shoal bottom which lay between the old pier and the new was dredged out early in the present season, under superintendence of Mr. Dever, to a depth of about − 25 feet L. W. D.[1]

Pile dike.—A dike was built in the lake, south of the south pier and at right angles to the latter, at 1,105 feet from east end and in front of the shore line, to protect the United States land and property from storms, and to afford a sheltered site for the later work of building a concrete sea wall. This dike consists of two rows of closely driven piles, 8 feet between centers, secured by wales, ties, and machine bolts, and filled with rock.

Pipe wells.—A timber well was sunk at rear side of each new pier near the center line of Lake avenue, for carrying water pipes and electric cables down to the base of the piers and thence under the piers and channel. Height, 22½ feet; outside dimensions, 7 feet 10 inches by 9 feet; inside, 6 by 6 feet, and provided with fixed ladders for the use of a diver. Built of 4 by 10 inch plank from the deck of the old south pier, with pockets or cells for gravel ballast, and iron tie rods with turnbuckles for securing it to the new pier. Calked to make it sand tight. Reaches 1 foot below bottom of pier. Will later be surmounted by a masonry manhole with iron cover. There is a small opening under each new pier leading from the pipe well to the channel.

The United States has placed a 2-inch heavy wrought-iron water pipe 26 feet long, with a temporary cap at each end, under each pier, which will be extended across the channel some time later when needed. Two telephone cables were placed under the canal and through the pipe wells in May, 1901, for which a revocable license was granted by the Secretary of War.

Removal of wrecked protection pier.—A large piece of timber crib was discovered in the channel, February 20, 1901, about 16 by 16 by 50 feet in size, lying about 75 feet north of center line and 150 feet west of east end of canal. This proved to be a portion of the outer protection pier, which was destroyed by a storm in October, 1900, as stated elsewhere. This wreck was raised and removed from the channel April, 1-11, 1901, by Whitney Brothers, and grounded at a point about 300 feet north of the new north pier and 75 feet from the east end. It has since drifted about 18 feet farther inshore. It is marked by an iron-shod pile driven into the timber and standing well above the water, also by a pile and a spar buoy near the south end of the wreck.

Spirit levels.—Levels have been taken from time to time, to points of the new pier, in order to determine the amount and rate of settlement, from the time the cribs were sunk until the present. The results of these observations on the south pier are given under another heading in the following pages.

TABLE 6.—*Cost of miscellaneous work at Duluth Canal for the year ending June 30, 1901.*

November and December, 1900, removing old south pier, by the Duluth Dredge and Dock Company	$15,000.00
January and February, 1901, building pile dike south of new south pier, by Whitney Bros	2,075.16
April, 1901, removing wreck of outer protection pier from canal channel, by Whitney Bros	600.00
1900-1901, building two pipe wells, by Butler-Ryan Company	309.30
June, 1901, laying water pipes under canal piers, by J. B. Wanless	53.33
May, 1900, building two signboards	23.67
June, 1901, removing shoal in canal south of old south pier and on line of same, 17,613 yards at 7½ cents, by Williams, Green & Williams	1,320.98
Extra allowance for dredging riprap	2,058.33
May, 1901, placing buoys on shoal in canal, by James Magee	5.00
Total	21,445.77
Inspection, incidentals, etc., 6 per cent	1,286.70
Total cost for year ending June 30, 1901	22,732.47

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[1] Other deepening was done in June, 1901, near outer end of canal, and for a distance into the lake, where the original depth was from about 20 to 25 feet, to give a least depth of 25 feet L. W. D., as a part of the regular contract for dredging in Duluth-Superior Harbor. For details, see report of F. L. Dever, assistant engineer, superintendent.

SETTLEMENT OF SOUTH PIER, DULUTH CANAL.

In case of a heavy mass of concrete resting on a timber crib 21 feet deep, and this in turn resting on bearing piles, the feature of settlement from compression of timber and closing up of joints is a matter of some interest. For the south pier sufficient time has now elapsed and enough observations taken to present fairly definite results. The amount proves to be somewhat greater than was expected, particularly at the pierhead, and yet it is not excessive or serious, while its uniformity is marked and satisfactory. The fact of settlement requires an instrument to detect it, as it is not observable to the eye, except where occasional joints in the concrete show a slight opening.

Foundation.—Some details of construction will first be given which have a bearing upon the subject. A section of the main pier is shown in fig. 3.

Each of the cribs (or caissons) is 100 feet long and 21 feet deep; top of crib is 1 foot below low-water datum. Width 24 feet, except for No. 1, which is 36 feet wide. Walls on channel side 2 feet thick, on rear side 1 foot thick. Transverse solid bulkheads are 10 inches thick and 4 feet between centers. Floor 8 inches thick, forming an even surface to come in contact with the bearing piles. Pockets filled with rock and gravel ballast, covered with deck timber 6 inches and 12 inches thick, timber hemlock and pine, with oak 1 foot thick and 7 feet high in upper part of the front wall, and steel plates 1 inch thick outside the oak. Timber sawed, not sized in planer, all sound and of good quality. No seams allowed to exceed one-fourth inch.

Bearing piles of Norway pine, averaging 13.9 inches diameter at cut-off,[a] penetrating into clear sand to 17 feet below cut-off, except that the upper 2 feet was filled in with rubble and gravel close up to cut-off. Piles sunk into place by water jet and a 2,800-pound hammer, so that the final penetration from last blow of the hammer, falling 15 to 30 feet, did not exceed 1 inch. Pile was sunk to nearly full depth by the water jet alone, and required but little driving. In nearly all cases the pile came to a dead stop, with no penetration from last blow; large end down and not pointed. Under these conditions it is estimated that each pile should be capable of sustaining a load of at least 75 tons without yielding, which is about four times the actual load.

Piles cut off 22 feet below low-water datum by means of a circular saw on vertical shaft in swinging leads, mounted on the standing piles. Saw adjustable and kept to uniform height as nearly as possible, as directed by a spirit leveler.

There are 150 piles to each regular crib, spaced 4 and 5 feet between centers, and for the pierhead crib the piles are spaced 4 feet each way. The height of each pile cut off was determined by a spirit level, using a rod about 32 feet long in order to reach the required depth, with scale at top of rod. A diver placed the lower end of the rod on each pile head in succession and brushed off any gravel or rock that was lying on them. The degree of accuracy in sawing is indicated to some extent by the following table:

TABLE 7.—*Range in elevations of pile cut-offs.*

Crib No.	Number of bearing piles.	Highest pile.[b]	Lowest pile.[b]	Range.
1	226	0.00	−0.21	0.21
2	150	+.01	− .12	.13
3	150	+.02	− .15	.17
4	150	+.05	− .10	.15
5	150	+.01	− .13	.14
6	150	−.01	− .09	.08
7	150	+.02	− .07	.09
8	150	+.01	− .09	.10
9	150	+.05	− .07	.12
10	150	+.04	− .06	.10
11	150	+.06	− .05	.11
12	150	+.03	− .04	.07
13	150	+.06	− .05	.11
14	150	+.02	− .05	.07
15	150	+.05	− .03	.08
16	150	+.07	− .03	.10
17	167	+.08	− .06	.14
Mean				.12

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[a] This is the average for the 226 piles under crib No. 1; remaining piles not greatly different.

[b] Referred to grade of cut-off which is 22 feet below L. W. D.

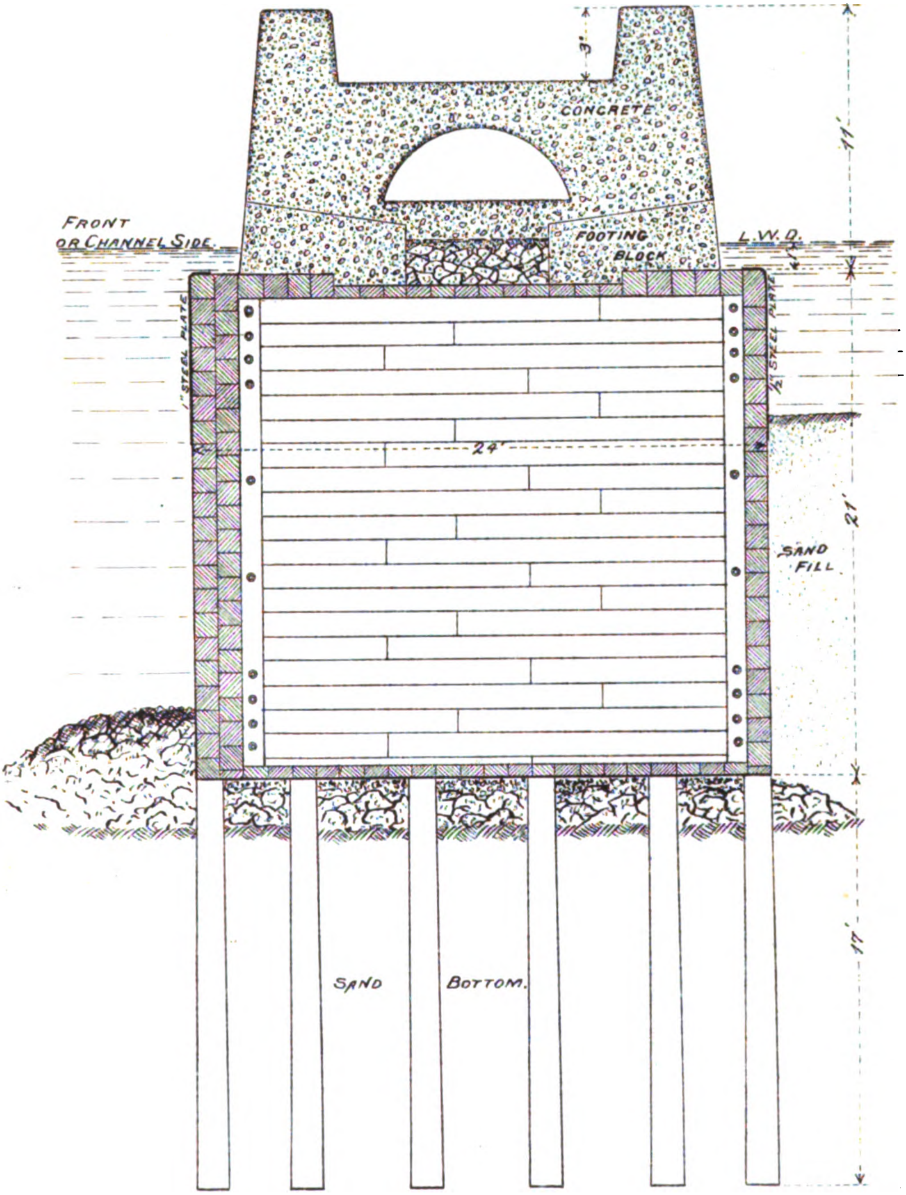

FIG. 3.
SECTION OF MAIN PIER

THE NORRIS PETERS CO. PHOTO-LITHO. WASHINGTON, D. C.

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Spirit levels.—Levels were taken at intervals to the top of crib walls, and to top of concrete superstructure after the latter was built. The dates and resulting elevations are given in Table 8, and some of the principal resulting settlements in Table 9.

A Buff & Berger precise level was used. Instrument in good adjustment, shielded from sun by an umbrella, self-reading rod. Three horizontal wires read on each point, and mean taken. Rod kept plumb by means of a spirit-level attachment. Fore sights and back sights were equal and 200 feet, with some unavoidable exceptions. Elevations depended upon a permanent bench mark, B. M. 28, on Lake avenue and Fulton street, and the greatest distance of any point on the pier from this bench mark was about 1,500 feet. Levels to the concrete were checked by closing a circuit, running out on one side of the pier and back on the other side, the closing error indicating a good degree of precision.

The levels to the cribs were taken under less favorable conditions, which prevented the desired uniformity in sight distances and the forming of circuits. An iron bolt with conical head formed a bench mark at each of the four corners of each regular 100-foot crib and at additional points on the first and last cribs, which were of special forms.

The observations and reductions were made by Mr. M. W. Lewis, junior engineer, draftsman, with the exception of a few in January, 1901, which were made by S. M. White, junior engineer, inspector.

THE PIERHEAD.

Weight of pierhead.—The elevated concrete of the pierhead rests upon crib No. 1 and reaches 6.5 feet over on crib No. 2. Crib No. 1 is 100 feet long by 36 feet wide, and has a pointed cutwater. Its construction is similar to that of one of the regular cribs already described, the chief difference being in the cutwater, which has intersecting bulkheads of thicker timber, more oak timber in the walls, and more steel-plate protection. The intersecting timbers result in more timber and less ballast for the cutwater, but this is offset in part by the additional heavier materials, oak timber, and steel.

The net weight of crib No. 1, after allowing for water displacement, is 1,622 tons of 2,000 pounds; that of crib No. 2, 1,200 tons, and of the 6.5 feet of No. 2, which is overlapped by the high concrete, 78 tons, making 1,700 tons for net weight[1] of cribs under the pierhead concrete. The method of determining this weight, a problem which admits of an entirely definite solution, is stated in the Annual Report of the Chief of Engineers for 1899, pages 2633–2638. The results are here corrected for the error in relative ballast, amounts for cribs 1 and 2 noted on page 2639 of same report.

The amount of concrete in the pierhead superstructure is 2,760 tons, consisting of 1 cutwater monolith of 335.9 tons, 6 standard monoliths of 251 tons each, 1 stairway monolith of 423 tons, besides the footing blocks and concrete between the latter, amounting to 89.2 tons under the stairway block and 58 tons under each of the other 7 blocks. Weight of concrete, 150 pounds per cubic foot.

I am indebted in great part to Mr. Clarence Coleman, United States assistant engineer, for the foregoing weights of concrete superstructure.

The buoyancy of water acting upon this concrete, computed for a stage of + 1 foot, low-water datum, gives a displacement of 6,952 cubic feet, which, at 62½ pounds, amounts to 217.2 tons. Deducting this leaves for the net weight of concrete in pierhead 2,543 tons. Adding the net weight of concrete to net weight of cribs already given makes the total net weight of pierhead 4,243 tons.[2]

Unit pressures.—The last-mentioned load is supported by 244 piles, giving an average load of 18.94 tons on each. This is far short of an extreme load for these piles. The mean diameter at cut-off of the piles under crib No. 1 is 13.9 inches, and those under the other cribs do not differ greatly from this.

The surface of cut-off for 13.9 inches diameter is 151 square inches, and the resulting load per square inch is 251 pounds. This is about one-twentieth of the ultimate resistance to crushing, lengthwise of the fiber, of the piles (which are of Norway pine) when dry, and probably not more than one-tenth of their resistance when wet. As to the floor in contact with the piles, it is of pine and hemlock, the fibers transverse to direction of force, and its ultimate resistance to crushing when dry, and in the form of small blocks of about 2 inches on a side, is something like 800 or 1,000 pounds per square inch, and evidently much less when wet, and the crushing is preceded by a compression, which may be one-tenth of the thickness of the piece. Am not aware of experiments on wet specimens; but the crib floor in question is 8 inches thick and laid close, making it practically of indefinite width and length, and there is a solid bulkhead directly above the pile. The pile also has a large bearing-surface, 151 square inches, so that the floor would not fail under compression like a small test block would. Probably no definite limit could be assigned for its ultimate resistance, but the pile undoubtedly penetrates or indents the floor softened by water soaking, under the given load, to an extent dependent not only upon the pressure, but the duration of the pressure, and more in case of the higher piles than with the lower ones. So that this penetration will account in part for the settlement of the pier.

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[1] The actual weight or weight in air would be 3,648 tons.

[2] Actual weight or weight in air would be 6,408 tons.

The concrete causes an average pressure of 12.7 pounds per square inch on the surface of the deck with which it is in contact, which is too small to cause any compression of fiber of the deck timber.

Where the deck timbers cross the bulkheads, which are 10 inches thick and 48 inches between centers, the average pressure for the surfaces in contact is 12.7 by $\frac{48}{10}$, equal to 61 pounds per square inch. This, while not sufficient to crush the pine or hemlock timber, must close up the seams between the timbers of the bulkheads tightly, and may slightly compress the timber itself. There are driftbolts 1 inch in diameter, round, driven vertically into these bulkheads every 2 feet, and these would resist, to a certain extent, such closing, but would have to yield to the force of 14,640 pounds, which would come on each bolt and allow the timber to slide over their surface. The seams were limited to one-fourth inch by the contract, but were seldom open as much as that and were generally in apparently close contact. The roughness of the sawed and unplaned surfaces would also, in effect, add to the seam space. Should think that one-thirty-second of an inch might be the average seam, and if so, the 20 horizontal seams in a bulkhead amount to five-eighths inch. The compression of the timber in the bulkheads might also be of sensible amount in so deep a crib, even with the moderate unit pressure of 61 pounds per square inch.

Settlement.—In the first seven months after sinking crib No. 1 had settled to 0.030 foot below mean pile cut-off, and in the next nine months only 0.007, indicating that a nearly stationary position had been reached before the concrete was added. The next four months showed 0.033 settlement, which was owing to the placing of the concrete footing blocks. Four months later and directly after the monoliths were built, there was a further settlement of 0.065 in the crib walls, and 0.051 more in the next three and one-half months. The sum of the last three, or 0.149 foot, is the settlement of the crib walls in twelve months preceding January 9, 1901, and is mainly due to the addition of the superstructure. The concrete does not rest on the walls, but springs from a line 2 feet from outer edge of crib.

Spirit levels to the crib walls were discontinued after January 9, 1901, and thereafter taken to the top of the concrete parapets. These points on the concrete correspond with those on the cribs in being nearly over the corners and angles of the crib.

The pier head concrete settled 0.195 foot in the first three months after building it, and in the next six months 0.043, showing a decreasing rate. It will likely be many months before all traces of settling disappear.

The crib walls settled 0.116 during approximately the same period that the concrete settled 0.195, showing that the crib deck and bulkheads under the concrete were pressed down more than the walls, which are outside the concrete.

The total settlement of the crib directly under the concrete, below the mean pile cut-off, or rather below a plane 21 feet (the height of the crib) above the latter, is approximately 0.308 foot, or about 3¾ inches, in the thirty-three months up to June 1, 1901. This is the sum of the amounts to columns 15, 17, and 18 in Table 9.

The five points on the pier head concrete have settled by the following amounts during the nine months, from time of building the monoliths up to June 1, 1901:

	Foot.
Cut-water vertex	0.252
North angle of cut water	.230
South angle of cut water	.216
Northwest corner	.244
Southwest corner	.250
Mean	.238

From this it will be seen that the pier head has settled quite uniformly.

The light and fog-whistle building, of stone, brick, and iron, and with a possible weight of 221 tons,[1] which is about to be built on this pier head, may be expected to add some to the settlement.

THE MAIN PIER.

Weight.—Each of the 100-foot cribs, when ballasted and complete, has a net weight when submerged of 1,234 tons[2] of 2,000 pounds. If it were in air the weight would be 2,599 tons, so that the loss of weight in water is a little more than one-half. The superstructure is made up of footing blocks of concrete of 7 tons each, concrete monoliths of 85.6 tons each, in case of a double parapet, and a rock and gravel filling between the footing blocks, weighing about 130 pounds per cubic foot in air, and 82 pounds when immersed. The weight of the superstructure per 100 feet, that is the part over one crib, is 1,216 tons. The buoyancy of water, when at a stage of +1 L. W. D., reduces this to a net weight of 1,090.1 tons. Sectional area of concrete is 151.7 square feet.

The net weight of entire section is, therefore, 2,324 tons per 100 feet. This rests upon 150 piles, giving an average load of 15.50 tons on each pile.[3] This is 82 per cent of load on pier-head piles.

Unit pressures.—Taking the diameter of pile at cut-off 13.9 inches, and area 151 square inches, gives a load of 205 pounds per square inch.

If we consider the pressure of the superstructure on the deck uniform for the entire area of contact, including the portion of deck under the filling of rubble and gravel which lies between the footing blocks, an assumption not strictly correct, as I believe, but approximately so, the resulting pressure per square inch is 7.57 pounds.

The bulkheads on which the deck rests are 10 inches thick, and spaced on an average of 48 inches between centers. The average pressure on these bulkheads, and upward against the deck in contact with them, is, therefore, 7.57 by $\frac{48}{10}$, or 36.3 pounds per square inch. This is 60 per cent of the corresponding pressure at the pier head.

Settling.—A less amount of settling should, therefore, be expected to take place in the main pier than in the pier head, after the superstructure was built, and this is observed to be the case. For example, compare the means for cribs 3 to 17,[4] in Table 9, columns 16, 17, 18, 19, with the amounts for No. 1 or pier head; but previous to building the superstructure the unit pressure between piles and floor of cribs was greater for the regular cribs, 2 to 17, than for crib No. 1, on account of the piles being spaced farther apart, and we find in column 15 that the average settlement for cribs 2, 3, 4, and 5 (which were sunk at about the same time with No. 1) is 0.086 foot, and greater than for No. 1, which is 0.070 foot. In same column the remaining cribs, 6 to 17, have generally smaller settlements, owing to being sunk later and standing a shorter time.

The settlements given in column 19 are the sum of those in columns 15, 17, and 18, and are not strictly exact, owing to the omission of the unknown settlement for the period of from one to five months between the dates given in column 8 and those in column 9 (or 12) when the forms were set, and also owing to the omission of the unknown amount by which the deck under the footing blocks settled in excess of the exterior crib walls, which carried the bench marks, during the period of one to two months between the dates in column 7 and column 8.

Crib No. 8 shows some greater settling than the other main cribs, up to November

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[1] This weight was estimated from the preliminary plans of October 15, 1898. I have not yet examined the final plans. According to the former there would be a concentrated load of 53 tons due to the tower and coal bunkers, and a fairly uniformly distributed load, due to brick walls and roof, of 168 tons, over the base of the building, and this base in turn covers less than half of the pier head, and is unsymmetrical with respect to the center lines. It would add 3 tons to each of about 30 of the foundation piles, 1.2 tons to each of about 138 piles, and the remaining piles would be but little affected. This estimation of load distribution is, however, necessarily inexact, owing to the depth of the pier.

[2] This is the mean of cribs Nos. 2 to 5. The method of determination is given in Annual Report of the Chief of Engineers for 1899, page 2633. The remaining cribs, with the exception of No. 17, at harbor end, are built and filled the same as the four mentioned, and must have nearly the same weight.

[3] The piles are not quite equally loaded. Taking one bent of six piles, the two outermost ones, under the edges of the crib, would have something less than 15.5 tons each and the others something more than that, but this variation will not be further considered here.

[4] Crib No. 2 is omitted from these means for the reason that the pier-head concrete overlaps one end of this crib and presses it down and makes the average for No. 2 intermediate in amount between that for the pier head and for Nos. 3 to 17.

22, 1900 (columns 15, 16, and 17), the reason for which is not apparent. Since that date its settlement has been very small.

The small amount of settlement of all the cribs for the last six months (see column 18, Table 9) being an average of 0.014 foot, or one-eighth inch, for the main cribs and 0.043, or one-half inch, for the pier head, shows a satisfactory condition as regards stability.

In what precedes no account has been taken of the support afforded to the cribs by the filling between the bearing piles, for the reason that the amount of such support is indeterminable, and because the piles are calculated to sustain the load alone.

This filling is about 2 feet deep, consisting of rubble filled nearly to the cut-off, and then covered with beach gravel which is leveled off so as a rule to be flush with the tops of the piles. The tendency was to overfill the spaces, which necessitated much tedious work by a diver to remove the excess. But there were spots where there was a deficiency, the filling being a few inches or even a foot below the cut-off.

The piles are unyielding, while the filling between them is a yielding material, and it would be hard to say how far it would settle under a load before it brought up firm. In the meantime it must of course sustain some portion of the weight, and to that extent relieve the load on the piles and diminish the compression of the crib floor in contact with the pile heads. It would not, however, lessen the compression of the timber above the floor in bulkheads and walls.

TABLE 9.—*Amount of settlement of South Pier, Duluth Canal, deduced from elevations o Table 8.*

Crib No.	15		16		17		18		19	
	For top of crib walls up to May, 1900, previous to building monoliths. (Referred to mean pile cut-off.)		For top of crib walls, from May, 1900, to November, 1900, or January, 1901. (During this period the monoliths were built.)		For concrete monoliths, from date of building to Nov. 22, 1900.		For concrete monoliths, from Nov. 22, 1900, to June 1, 1901.		Total for crib deck, under monoliths, from date of sinking crib to June 1, 1901. (Referred to mean pile cut-off.)	
	Months.	Amount.	Months.	Amount.	Months.	Amount.	Months.	Amount.	Months.	Amount.
		Feet.		*Feet.*		*Feet.*		*Feet.*		*Feet.*
1 (or pier head)	20	0.070	8	0.116	3	0.195	6	0.043	33	0.308
2	20	.097	6	.071	3	.120	6	.043	33	.265
3	19	.087	6	.033	3	.059	6	.033	32	.179
4	18	.101	6	.027	3	.066	6	.019	31	.186
5	18	.060	6	.042	4	.066	6	.010	30	.136
6	11	.080	6	.057	4	.059	6	.014	24	.153
7	11	.027	6	.077	4	.082	6	.012	23	.121
8	8	.109	6	.105	4	.118	6	.006	21	.233
9	8	.047	6	.099	4	.089	6	.008	20	.144
10	8	.012	6	.092	4	.095	6	.015	20	.122
11	7	.031	6	.090	3	.104	6	+.011	20	.124
12	7	.017	6	.099	3	.093	6	+.003	19	.107
13	6	.077	6	.071	3	.091	6	.001	19	.169
14	6	.033	6	.062	1	.070	6	.022	18	.125
15	6	.019	6	.062	1	.075	6	.021	18	.115
16	5	.038	6	.065	1	.082	6	.027	18	.147
17	4	.019	6	.079	1	.076	6	.033	17	.128
Mean for cribs Nos. 3 to 17	9	.050	6	.071	2.8	.082	6	.014	22	.146

Respectfully submitted.

J. H. DARLING,
Assistant Engineer.

Capt. D. D. GAILLARD,
Corps of Engineers, U. S. A.

K K 4.

IMPROVEMENT OF HARBOR AT ASHLAND, WISCONSIN.

The southern end of Chequamegon Bay forms the harbor of Ashland, and as the length of the bay is considerable it was necessary to protect the wharves from waves to enable vessels to use them at all times.

The original project was for the construction of a pile, slab, and rock breakwater 8,000 feet long, and for dredging a channel of the necessary depth along the dock line. The act of March 3, 1899, practically added 2,200 feet to the original project of 8,000 feet, thus making 10,200 as the length.

The act of June 6, 1900, provides as follows:

> * * * That in lieu of completing the shore end of the breakwater at Ashland, Wisconsin, as provided for in the river and harbor act of March third, eighteen hundred and ninety-nine, there shall be substituted a breakwater, starting at a point on the shore about two thousand six hundred feet east of the point at which the existing shore arm of breakwater would meet shore if prolonged, and running in a direction parallel to existing breakwater for a distance of four thousand seven hundred feet, or of such length as may be necessary to fully protect the harbor of Ashland.

This enlarged the project and added very materially to the cost.

Before the passage of this act a contract had been made for building about 1,200 linear feet of breakwater, to start from the shore and run out toward the old work on the prolongation of its axis. At the time of the passage of this act about 91 feet of this shore end had been completed. The new law made it obligatory to abandon this work and start over again at the new site.

The present length of the two sections of breakwater on the original line is 7,454 feet, and that on the line fixed by the act of June 6, 1900, is 842 feet. This gives a protected area of some 1,600 acres, and affords safe anchorage and dockage for 3 miles along the city front.

The amount expended on this harbor up to the close of the fiscal year ending June 30, 1900, is $248,752.31, of which $127,000 has been for the construction of the breakwater, $81,444.04 for repairs to same, $31,000 for closing the breach in Chequamegon Point and repairing the same, and $9,308.27 for dredging. The dredging has given a channel of 20 feet depth and from 124 to 150 feet in width from opposite Ellis avenue to a point in prolongation of Eleventh avenue west, a distance of about 3,460 feet. The dredged material was deposited against the old and weaker portion of the breakwater.

The breakwater has fully accomplished the object of its construction, and will continue to do so as long as it is kept in repair. It consists of three rows of piling filled in between with slabs which are anchored with large rocks.

This construction has only its original cheapness to commend it, and is proving very expensive to maintain.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1901.

The act of March 3, 1899, appropriated $35,000 for the continuation of the improvement of this harbor. Of this, about $25,000 was expended in the construction of 91 linear feet of breakwater, on the line of the old breakwater, but next to the shore, and of 842 linear feet of breakwater, of the same type as the old one, on the newly projected location 2,600 feet east of the old line, as provided in the act of June 6, 1900.

The change in location entailed additional expense for the contractors, Hugo & Tims, who had already commenced the work of breakwater extension on the original line, on account of the harder bottom at the new site and the difficulty of driving piles (see Report of the Chief of Engineers, U. S. A., for 1900, p. 3592); for which reason claims were filed by them, and allowed to the amount of $6,108.71.

The principal shipments from Ashland are iron ore and lumber. Congress has appropriated between 1886 and 1901, both inclusive, $274,500 for the improvement of this habor.

The commerce of this port during this period has increased from 892 arrivals and clearances, with cargo tonnage of 1,400,000 tons, in 1887, to 2,335 arrivals and clearances, with cargo tonnage of 3,295,837 tons, in 1900. During this period the commerce of the port is roughly estimated at a valuation of $370,000,000.

This work is in the collection district of Superior, Mich., Marquette, Mich., being the port of entry; nearest light-house, La Pointe, on Chequamegon Point, at entrance of Chequamegon Bay.

Money statement.

July 1, 1900, balance unexpended		$25,747.69
June 30, 1901, amount expended during fiscal year		24,799.14
July 1, 1901, balance unexpended		948.55
Amount (estimated) required for completion of existing project		426,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901:		
For works of improvement	$50,000.00	
For maintenance of improvement	15,000.00	
		65,000.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

Abstract of appropriations for improving harbor at Ashland, Wis.

By act of Congress—

Approved Aug. 5, 1886	$22,500
Of Aug. 11, 1888	60,000
Approved Sept. 19, 1890	60,000
Approved July 13, 1892	45,000
Of Aug. 18, 1894	25,000

By act of Congress—

Passed June 3, 1896	$27,000
Approved Mar. 3, 1899	35,000
Total	274,500

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels for seven years.

Year.	Number.	Average tonnage.
1893	6,052	1,178
1894	6,142	
1895	5,227	
1896	5,164	
1897	(a)	(a)
1898	2,981	1,311
1899 (steamers, 1,467; schooners, 896)	2,363	1,657
1900	2,335	1,296

a No report.

Arrivals and clearances of vessels for 1900.

	Foreign.	Domestic.	Total.
Arrivals	43	1,122	1,165
Clearances	10	1,160	1,170

Principal articles of export and import for 1900.

Exports.	Tons.	Imports.	Tons.
Pig iron	14,561	Coal	298,458
Iron ore	2,629,946	Miscellaneous merchandise	1,385
Lumber	351,487		
Total	2,995,994	Total	299,843

Total receipts and shipments.......tons.... 3,295,837
Total valuation....... $15,119,497

Comparative statement of receipts and shipments for thirteen years.

Year.	Tons.	Year.	Tons.	Year.	Tons.
1887	1,401,454	1892	4,267,097	1897	(*a*)
1888	1,357,472	1893	2,759,870	1898	2,808,891
1889	1,971,218	1894	2,982,502	1899	3,293,478
1890	2,816,924	1895	3,747,251	1900	3,295,837
1891	3,217,541	1896	2,391,337		

a No report.

Arrivals and clearances of vessels for thirteen years.

Year.	Number.	Year.	Number.	Year.	Number.
1887	892	1892	7,104	1897	(*a*)
1888	2,875	1893	6,052	1898	2,981
1889	3,171	1894	6,142	1899	2,363
1890	4,489	1895	5,227	1900	2,335
1891	4,099	1896	5,164		

a No report.

From 1893 to 1896, inclusive, report includes the ports of Washburn and Bayfield, on Chequamegon Bay.

The figures for 1900 are furnished this office by the deputy collector of customs at Ashland.

K K 5.

IMPROVEMENT OF HARBOR AT ONTONAGON, MICHIGAN.

This harbor is formed by the mouth of the Ontonagon River, which flows out between two piers 2,315 and 2,675 feet in length, respectively. The project is for maintaining a navigable depth of 12 feet between these piers and up to the bridge just inside the entrance. This is done by dredging annually or biennially, as may prove necessary, at an annual cost of from $5,000 to $10,000.

For the history of this improvement see annual report for 1896.

The total cost of the improvement to June 30, 1901, has been $344,661.31, giving a good navigable 12-foot channel between the piers.

From the balance of the $10,000 appropriated by the act of June 3, 1896, $6,845.63 was expended, under contract with McCurdy Brothers, of Houghton, Mich., the lowest bidders, in repairs during the season of 1900 to the outer 1,120 feet of the east pier, which was in a very rotten condition above the +2-foot line. The old timber superstructure was cut down and replaced with new timber, at $29.93 per M feet B. M.

The spring floods in the Ontonagon River bring down much sediment, which is deposited between the piers and at the entrance, necessitating dredging every few years. For this purpose and for minor repairs to the piers a maintenance fund of $8,000 should be provided.

A fire in August, 1896, almost obliterated the town, destroying all its commercial industries and wiping out most of the business and residence portions.

This work is in the collection district of Superior, Mich. Nearest port of entry, Marquette, Mich. A light is shown on the outer end of the west pier at Ontonagon, Mich.

Money statement.

July 1, 1900, balance unexpended	$7,821.54
June 30, 1901, amount expended during fiscal year	7,354.85
July 1, 1901, balance unexpended	466.69
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement, in addition to the balance unexpended July 1, 1901 Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	8,000.00

Abstract of appropriations for improving harbor at Ontonagon, Mich.

By act of Congress—

Approved March 2, 1867	$97,600
Approved July 7, 1870	10,000
Approved June 23, 1874	23,000
Approved March 3, 1875	25,000
Approved August 14, 1876	15,000
Approved June 18, 1878	15,000
Approved March 3, 1879	17,000
Approved June 14, 1880	15,000
Approved March 3, 1881	20,000
Passed August 2, 1882	20,000
Approved July 5, 1884	15,000

By act of Congress—

Approved August 5, 1886	$13,000
Passed August 11, 1888	12,500
Approved September 19, 1890	10,000
Approved July 13, 1892	20,000
Passed August 7, 1894	7,000
Passed June 3, 1896	10,000
Received on account of damage to piers	28
Total	345,128

COMMERCIAL STATISTICS, ONTONAGON, MICH.

Arrivals and clearances of vessels for 1900.

	Arrivals.		Clearances.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	84	23,000	84	23,000
Sail	4	1,000	4	1,000
Total	88	24,000	88	24,000

Arrivals and clearances of vessels for seven years.

Year.	Arrivals.	Clearances.	Total.
1893	[a]77	77	154
1894	211	211	422
1895	494	492	986
1896	([b])		
1897	88	88	176
1898	107	107	214
1899	197	197	394
1900	88	88	176

[a] In addition there were a number of arrivals during the season of both steam and sailing vessels seeking refuge during heavy weather, and frequent arrivals of fishing and other tugs.

[b] No report.

Principal articles of import and export for 1900.

Imports.	Tons.	Exports.	Tons.
General merchandise	2,007	General merchandise	97
Coal	350	Lumber	3,750
		Fish	143
		Copper	1,005
Total	[a]2,357	Total	[b]4,995

[a] Does not include 200,000 feet of logs.

[b] Does not include 1,100,000 feet of logs.

Receipts and shipments for six years.

Year.	Tons.	Year.	Tons.
1893	178,100	1897	([a])
1894	182,790	1898	187,050
1895	181,050	1899	8,218
1896	([a])	1900	[b]7,352

[a] No report.

[b] 1,300,000 feet of logs not included.

Through error in the reports made to this office, the quantities of lumber of all kinds in reports previous to 1899 were given one thousand times too large.

K K 6.

IMPROVEMENT AND OPERATING AND CARE OF WATERWAY FROM KEWEENAW BAY TO LAKE SUPERIOR, MICHIGAN.

A full history of this work and of its purchase by the United States is given in Appendix II, Part III, Report of the Chief of Engineers, United States Army, 1892, under the title of "Portage Lake and Lake Superior canals across Keweenaw Point, Michigan."

The full report of The Board of Engineers, constituted in compliance with the provisions of the river and harbor act of August 5, 1886, is given in House Executive Document No. 105, Forty-ninth Congress, second session.

The project, as recommended by this Board and approved by the Chief of Engineers and the Secretary of War, provides for a 20-foot navigation through channels of 120 feet bottom width; for the extension of the Keweenaw entrance pier, 2,800 feet to 20 feet depth in

Keweenaw Bay; for two breakwater piers, each about 2,740 feet long at the upper entrance, and for revetting the banks of all the artificial channels.

Maps of this waterway are given in the annual report for 1896, pages 2364 and 2365.

At the time of purchase by the United States there was a very poor 13-foot navigation; the channel was narrow and crooked, with many sharp bends; it was poorly marked and lighted; the entrance piers were in a very bad condition; the revetments were rotten, or entirely gone, and there was a heavy tax on the commerce through the canals in the shape of a tonnage charge.

This charge was abolished when the United States assumed control of the canals.

With the $230,000 appropriated since the purchase, but before the appropriation of June 4, 1897, the entrance piers were repaired and put in good condition; the revetments most necessary for preserving the banks of the canal were renewed with substantial timber structures; the channel was deepened to give a good 16-foot navigation at low-water datum, with 70 feet width; many points were cut away and several bends eased off, and Lily Pond, near the upper entrance, the passing place for vessels and their harbor of refuge, was widened to 300 feet, and a strong bulkhead revetment, with mooring posts, was provided.

The act of June 3, 1896, authorized continuous contracts for the improvement of this waterway to the amount of $1,065,000.

The following amounts have been appropriated under this act to carry out the approved project:

Sundry civil act of—	
June 4, 1897	$350,000
July 1, 1898	450,000
June 6, 1900	110,000
March 3, 1901	145,000
Total	1,055,000
Balance unappropriated	10,000

With these appropriations the following work had been accomplished up to June 30, 1900:

At the lower entrance 2,800 linear feet of pier extension had been built at a cost of $113,743. The total length of pier, old and new, now extending into Keweenaw Bay is 3,700 feet. The pier extends to 20 feet depth of water at low-water datum, and gives an excellent protection to the lower entrance.

Dredging had been done, under the Racine Dredge Company's contract, to the amount of 1,065,314 yards, at a cost of $90,833, giving a very fair 20-foot channel from Keweenaw Bay into Portage Lake through Portage River.

Pile and timber revetment of the channel banks in Portage River was constructed to the extent of 7,452 linear feet at a cost of $52,681. This revetment fully protects the banks in the cuts and elsewhere along the river where needed from the wash of passing vessels, and will permit a greater speed than the five miles an hour to which boats, by regulations, have heretofore been limited.

Under the Porter Brothers contract, still operative, there was constructed at the upper entrance a total length of west pier of 2,114 feet at a cost of $187,732, viz: Section 1, 1,450 feet; section 2, 664 feet, besides 350 feet of crib foundation. At the framing mill nine cribs of 100 feet each were built, but not sunk.

Under the Hingston & Woods contract for widening and deepening the Upper Canal and Lily Pond, still in force, 896,673 cubic yards of dredged material were taken out at a cost of $82,127.

The removal of 3,816 linear feet of old pile and crib revetment, including the construction of a temporary crib bulkhead at the head of the canal on the east side to protect the bank until it can be secured by the permanent revetment, was done under agreement with John McCallum, at a cost of $6,400.

These six items amount to $533,516, exclusive of administration, inspection, contingencies, and extra work.

About 53 acres of land were purchased at the upper entrance, under condemnation proceedings, at a total cost of $6,884, and 120 acres bought directly from the owners, by quitclaim deed, at a cost of $300.

The total amount expended from the date of purchase by the United States to June 30, 1900, was $740,243.42.

Operations during the fiscal year ending June 30, 1901, have been conducted under three contracts, all of which are now in force. These contracts are as follows:

BREAKWATER PIERS AT UPPER ENTRANCE.

Contract with Porter Brothers, of Duluth, Minn.

Total amount of work done under this contract from June 30, 1900, to June 30, 1901, is as follows:

Cribs:		
Cribs built, section 1, west breakwater		0
Cribs built, section 1, east breakwater	linear feet	1,096
Cribs built, section 2, west breakwater	do	230
Cribs built, section 2, east breakwater	do	783
Cribs placed, section 1, west breakwater	do	200
Cribs placed, section 1, east breakwater	do	1,599
Cribs placed, section 2, west breakwater		0
Cribs placed, section 2, east breakwater	linear feet	341
Superstructure:		
Linear feet placed on section 1, west breakwater		550
Linear feet placed on section 1, east breakwater		555
Linear feet placed on section 2, west breakwater		0
Linear feet placed on section 2, east breakwater		0
Stamp sand:		
Total amount of sand put in work	cubic yards	13,127

DREDGING IN UPPER CANAL AND LILY POND.

Contract with Hingston & Woods, of Buffalo, N. Y.

Total amount of dredging done under this contract from June 30, 1900, to June 30, 1901, is as follows:

Section 1, hard material	cubic yards	501,728
Section 2, soft material	do	248,306

REVETMENT WORK IN UPPER CANAL AND LILY POND.

Contract with Hugo & Tims, of Duluth, Minn.

Total amount of work done under the contract of July 18, 1899, from June 30, 1900, to June 30, 1901, under each head is as follows:

Regular revetment, 12 feet wide	linear feet	529
Regular revetment, 8 feet wide	do	7,089
Pile pier revetment in Lily Pond	do	4,101

During a severe storm on September 16, 1900, three cribs, which had not been entirely filled with rock, were carried away from their positions on the east breakwater and one of them considerably damaged. Two of the cribs were 100 feet each in length, and the third crib 97 feet in length. All were 30 feet in width and 18½ feet in depth. The damaged crib has since been turned over and repaired by the contractors. The United States suffered no loss from the displacement of these cribs, as they are maintained at the contractor's risk until accepted by the United States and paid for.

FUTURE OPERATIONS.

In order to complete these contracts the following work remains to be done, all of which it is believed will be completed during the present season:

Breakwater piers.

[Porter Bros.]

Cribs:		
Cribs to be placed, section 1 east	linear feet..	197
Cribs to be placed, section 2 west	do....	230
Cribs to be placed, section 2 east	do....	442
Superstructure:		
Superstructure for section 1 east	do....	1,245
Superstructure for section 2 west	do....	230
Superstructure for section 2 east	do....	783

Large riprap to be placed alongside cribs according to paragraph, 46 of the specifications:
1,300 linear feet each side section 1, west breakwater.
1,800 linear feet each side section 1, east breakwater.
550 linear feet each side section 2, east breakwater.

Dredging.

[Hingston & Woods.]

Section 1, hard material	cubic yards..	60,000
Section 2, soft material	do....	50,000

Revetment work.

[Hugo & Tims, contract July 18, 1899.]

Regular revetment, 8 feet wide	linear feet..	1,065
Pile pier revetment	do....	659

After due advertisement a contract was entered into June 1, 1901, with Hugo & Tims, of Duluth, Minn., lowest bidders, for constructing about 3,000 linear feet of pile and timber revetment near the upper end of the Upper Canal, and about 1,000 feet of revetment below Lily Pond in soft bottom, work to commence on July 1, 1901, and be completed by November 15, 1901.

On May 28, 1901, a contract was entered into, after due advertisement, with the Duluth Dredge and Dock Company, of Duluth, Minn., lowest bidders, for dredging about 93,000 cubic yards of material in Portage River. Work to be begun by August 1, 1901, and completed by November 1, 1901. The price to be paid is 8 cents per cubic yard for soft material and 11 cents per cubic yard at a section where both hard and soft material will be encountered.

When the foregoing operations are finished it is believed that the approved project will have been successfully completed, with the exception of removing old piers, building watchmen's houses, purchasing land for a site for one of the latter at the lower entrance, providing for such contingencies and extra work as can not be foreseen in advance, and removing such shoal places as may develop from caving, or running in of unprotected banks before the revetment is completed. Should these shoals be formed they can be removed next season, provided the balance of $10,000 authorized by the act of June 3, 1896, and not yet appropriated be made available in time.

Maps showing work completed and that yet to be done are submitted herewith.

The record of vessels and tonnage herewith submitted shows the great amount of commerce using this waterway and how important a link it is in the chain of lake navigation.

During the last season, that of 1900, the commerce through this waterway showed a considerable increase over that of 1899, the gain in total net freight tonnage being about 22 per cent, the record being as follows: Vessels entering and departing, 2,948; registered tonnage, 1,713,660; net freight tonnage, 1,734,136; valued at $57,380,129, not including local tug business, estimated at $1,000,000.

OPERATING AND CARE.

Location.—The Portage Lake ship canals constitute the waterway across Keweenaw Point, in the State of Michigan, from Keweenaw Bay to Lake Superior, there being about 25 miles of water route, consisting of 5½ miles of Portage River with its four cuts, 17 miles of Portage Lake, and 2½ miles in the upper canal from the head of Portage Lake to Lake Superior.

Under authority of the river and harbor act of September 19, 1890, the Secretary of War allotted $8,300 for operating and care of canals and other works of navigation, to be applied to Portage Lake and Lake Superior canals, Michigan, for the fiscal year ending June 30, 1901.

The approved project for the expenditure of this allotment is to maintain the depth and width obtained by the work of improvement; to keep a record of the vessels and their tonnage using the canals; to exercise the necessary care in enforcing regulations for the use of the canals; to make frequent surveys to determine changes, and to check up work done in dredging; to guard against encroachments on the legally established harbor lines, and to perform other work incident to the operation and care of the canals. The amount allotted has been expended in removing 35,000 cubic yards of material from the upper canal, under contract with Hingston & Woods, of Buffalo, N. Y., at a cost of $3,850, and in carrying out the usual routine requirements of the project.

The least depth in Portage River for the full channel width of 120 feet is 18 feet.

A contract has been entered into with the Duluth Dredge and Dock Company to do dredging under "Improving waterway in Portage River" that will probably put the channel in good condition; work to commence August 1, 1901. In the upper canal it is impossible to maintain a channel of any positive depth while the dredges are working, and until after the revetment work to protect the banks is completed. Eighteen feet depth of water can be counted on for the present, and with the exception of about 2,000 linear feet of canal, a depth of 21 feet prevails. Both the work of dredging and revetment construction are expected to be completed in November, 1901.

The railroad and wagon road bridge across Portage Lake, between Houghton and Hancock, continues an obstruction to navigation, by reason of the narrowness of the draw openings. A special report on this has been submitted, in which it is recommended that the owners (Houghton County) be required to replace the present drawspan by one constructed in accordance with plans submitted to the Secretary of War by the supervisors of Houghton County and approved by him January 7, 1901.

This waterway is located in the district of Superior, Michigan, with Houghton, Mich., as the nearest port of entry. At the Keweenaw Bay entrance there is a United States light-house on the point one-half mile north of the entrance, and two range lights for guiding in through cut 1. A temporary light has also been placed on the outer end of the pier at Portage entry. Besides the two range lights at Portage entry, there are 16 single and range lights along Portage River, two of them being range lights at the head of the river. Along Portage Lake there are single lights at Pilgrim Point shoal, at Osceola Dump, at Atlantic Dump, at Coles Creek, at Harrington Island, and at High Point, and range lights near head of Portage Lake to be used after rounding High Point, and two range lights at Portage Lake entrance to the upper canal. At the Lake Superior entrance there is a regular United States light-house on the west bank of the canal with a range light and fog signal on the outer end of the old west pier. The west breakwater is now so nearly completed that there should be a good light and a fog signal at the outer end of this breakwater. The channel in Portage River and shoal places along Portage Lake are now well marked by buoys.

The immediate charge of this waterway has continued under the management of Mr. G. A. Marr, as assistant engineer and superintendent.

Money statements.

IMPROVEMENT.

July 1, 1900, balance unexpended	$399,751.11
Reimbursement by Quartermaster's Department, October, 1900	[1]5.47
Amount appropriated by sundry civil act approved March 3, 1901	145,000.00
	544,756.58
June 30, 1901, amount expended during fiscal year	281,603.88
July 1, 1901, balance unexpended	263,152.70
July 1, 1901, outstanding liabilities	50,897.92
July 1, 1901, balance available	212,254.78
July 1, 1901, amount covered by uncompleted contracts	182,500.42
Amount (estimated) required for completion of existing project	10,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	10,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

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[1] $5.47 credited this appropriation account reimbursement by Quartermaster's Department, October, 1900, for mileage paid Michigan Central Railroad in November, 1898. Certificate settlement No. 13026, E. D. 22433/60, October 24, 1900.

OPERATING AND CARE OF CANALS.

July 1, 1897, amount allotted for fiscal year 1898	$8,300
June 30, 1898, amount expended during fiscal year	8,300
July 1, 1898, amount allotted for fiscal year 1899	8,300
June 30, 1899, amount expended for fiscal year 1899	8,300
July 1, 1899, amount allotted for fiscal year 1900	8,300
June 30, 1900, amount expended for fiscal year 1900	8,300
July 1, 1900, amount allotted for fiscal year 1901	8,300
June 30, 1901, amount expended for fiscal year 1901	8,300
July 1, 1901, amount allotted for fiscal year, 1902	8,500

Abstract of appropriations for improving waterway from Keweenaw Bay to Lake Superior, Michigan.

By act of Congress—	
Approved July 13, 1892	$50,000
Of August 18, 1894	130,000
Passed June 3, 1896	50,000
Approved June 4, 1897	350,000
Approved July 1, 1898	450,000
Approved June 6, 1900	110,000
Approved March 3, 1901	145,000
Total	1,285,000

The following statement shows the manner in which the appropriations have been expended. The amount expended under the different classes of work includes the cost of examinations, soundings, superintendence, buoying, and contingencies:

Dredging	$403,837.61
Pier work, revetment, etc	608,825.69
Purchase of land	9,184.00
Total	1,021,847.30

LIST OF EXISTING CONTRACTS.

Contract with Porter Brothers, of Duluth, Minn., dated September 22, 1897, approved October 13, 1897, for building breakwater piers at Lake Superior entrance to Portage Lake Ship Canal, Michigan, work to commence May 1, 1898, and be completed November 1, 1900. Time extended to November 1, 1901, by authority Chief of Engineers, September 22, 1900 (E. D. 22661/22). Prices per running foot (using white pine for superstructure) as follows: Section 1, E. and W., $65.25; section 2, E. and W., $24.22; stamp sand in place, 70 cents per cubic yard.

Contract with Hingston & Woods, of Buffalo, N. Y., for dredging in widening upper canal, Portage Lake ship canals, Michigan, dated February 16, 1899, approved March 21, 1899, work to commence May 15, 1899, and be completed November 1, 1900. Time extended by Chief of Engineers to August 1, 1901. Supplemental contract dated April 25, 1901 (E. D. 29806/22). Prices per cubic yard: Section 1, 11 cents; section 2, 9 cents. Use of plant, large, $30 per hour; use of plant, small, $12 per hour.

Contract with Hugo & Tims, of Duluth, Minn., for revetment work, Portage Lake ship canals, Michigan, dated July 18, 1899, and approved August 17, 1899, work to commence June 1, 1900, and be completed November 1, 1901. Supplemental contract changing width of revetment from 12 to 8 feet, in above contract, entered into January 18, 1900, and approved by Chief of Engineers February 21, 1900, and by Secretary of War March 1, 1900. Prices: Regular revetment, 8 feet wide, $7.76 per linear foot; pile pier revetment, $11.65 per linear foot; crib pier revetment, $22 per linear foot.

Contract with Hugo & Tims, Duluth, Minn., for revetment work, dated June 1, 1901, approved June 19, 1901, work to commence July 1, 1901, and be completed November 15, 1901. Prices: Regular revetment above Lily Pond, hard bottom, $10.12 per linear foot; regular revetment below Lily Pond, soft bottom, $9.48 per linear foot; two pile clusters, complete, $75 each.

Contract with Duluth Dredge and Dock Company, Duluth, Minn., for dredging in Portage River, dated May 28, 1901, approved June 6, 1901, work to commence August 1, 1901, to be completed November 1, 1901. Prices: Section 1, 11 cents per cubic yard; section 2, 8 cents per cubic yard; use of plant, $16 per hour.

COMMERCIAL STATISTICS.

Statistics of vessels passing through the canals during the calendar year 1900.

	Bound up.		Bound down.	
	Number.	Net tonnage.	Number.	Net tonnage.
Steam	1,244	828,846	887	402,213
Sail	566	821,704	801	160,897

Statement of freight and passengers carried through the Portage Lake and Lake Superior canals during 1900.

Bound up.	Net tons.	Bound down.	Net tons.
Coal, hard	48,508	Copper	48,156
Coal, soft	801,759	Flour	33,317
Manufactured iron	4,301	Grain	13,058
Salt	15,266	Pig iron	8,110
Copper	27,351	Iron ore	61,606
Miscellaneous merchandise	180,474	Lumber	437,690
Lumber	12,075	Miscellaneous merchandise	42,465
Total	1,089,734	Total	644,402
Passengers	16,331	Passengers	16,544

RECAPITULATION.

	Bound up.				Bound down.			
	1900.		1899.		1900.		1899.	
	Total.	Upper Canal.	Total	Upper Canal.	Total.	Upper Canal.	Total.	Upper Canal.
Number of vessels	1,810	1,310	1,550	1,288	1,188	800	892	626
Net tonnage	1,150,550	843,172	912,959	807,510	563,110	362,892	403,663	293,091
Freight ... tons	1,089,734	447,947	886,648	840,837	644,402	589,410	536,136	476,621
Passengers ... number	16,331	14,963	17,123	13,742	16,544	14,451	17,591	18,032

Statistics of tugs passing through the canals during the calendar year 1900.

	Bound up.	Bound down.
Trips ... number	544	528
Net tonnage ... tons	18,145	17,486
Vessels ... number	6	12
Scows ... do	885	861
Rafts ... do	50	68
Booms ... do	85	52
Logs ... M feet	5,116	16,008
Lumber ... do	5,120	130
Timber ... do	6,110	500
Sand ... tons	600	....
Railroad ties ... number	6,400	....
Cord wood ... cords	422	....
Coal ... tons	1,200	160
Building stone ... do	65,080	....
Miscellaneous merchandise ... do	574	....
Manufactured iron ... do	430	50
Hay ... do	90	....

Statistics of vessels passing through the Upper Canal (Portage Lake ship canals) for the calendar year 1900.

	Steam vessels.		Sailing vessels.		Cargo (net tons).	Passengers.
	Number.	Net tonnage.	Number.	Net tonnage.		
Bound up	910	629,848	400	213,824	447,947	14,963
Bound down	567	250,508	233	112,884	589,410	14,451

Recapitulation (Portage Lake ship canals).

Year.	Bound up and down.			
	Number of vessels.	Net registered tonnage.	Total freight.	Number of passengers.
			Tons.	
1892	1,470	665,063	496,288	30,098
1893	1,408	669,510	532,628	27,084
1894	1,724	860,618	754,973	32,636
1895	1,731	956,779	821,962	24,809
1896	1,774	1,028,979	918,924	41,262
1897	1,526	986,740	920,546	34,936
1898	2,176	1,387,310	1,226,023	30,405
1899	2,442	1,316,622	1,422,784	34,714
1900	2,948	1,713,660	1,734,136	32,875

There has generally been some difficulty in getting full reports from vessel captains for statistics, but after the close of navigation last season quite full reports were obtained from all vessels using these canals, except three or four, by writing to the captains when known, or to the owners, with better results than in any previous season. During the season there was a large increase in net registered tonnage and in the number of sail vessels, or barges other than steam, but a less number of steamers. As all sail vessels and barges are towed through as consorts to some steamer, it shows that steam barges are taking more vessels at a tow than formerly. For comparison between the seasons of navigation of 1899 and 1900, the total number of vessels bound up in 1899 was 1,550, with a tonnage of 912,959 net tons and 886,648 net tons of freight; and in 1900 the total number of vessels bound up was 1,810, with a tonnage of 1,150,550 net tons and 1,089,734 net tons of freight. For the bound-down traffic in 1899 there was a total number of 892 vessels, with a tonnage of 403,663 net tons and 536,136 net tons of freight; while in 1900 the total number of vessels was 1,138, with a tonnage of 563,110 net tons and 644,402 net tons of freight—quite a perceptible increase. To give a comparative statement for up and down business combined, the following table is submitted:

Items.	Price per unit.		Total valuation.	
	1899.	1900.	1899.	1900.
Coal, soft .... tons..	$3.30	$3.30	$1,956,084.90	$2,650,292.70
Coal, hard .... do....	5.25	5.25	245,726.25	254,667.00
Flour .... barrels..	3.75	3.75	1,288,623.75	1,249,406.25
Wheat .... bushels..	.75	....	185,496.00	....
Other grain .... do....	.70	.70	122,709.30	365,629.60
Manufactured iron .... tons..	60.00	60.00	1,669,260.00	286,860.00
Pig iron .... do....	20.00	16.00	189,200.00	129,760.00
Iron ore .... do....	2.00	2.25	118,028.00	138,613.50
Salt .... barrels..	.85	.90	37,638.00	96,174.00
Copper .... tons..	340.00	340.00	24,588,800.00	25,672,880.00
Lumber .... M. feet..	15.50	14.00	3,310,273.00	3,517,262.00
Logs .... do....	10.00	11.00	397,850.00	232,364.00
Building stone .... tons..	6.50	6.50	257.354.50	423,020.00
Unclassified .... do....	100.00	100.00	20,627,800.00	22,363,700.00
Total	....	....	54,994,843.70	57,380,129.05

This table gives only the regular through business of these canals both ways. Besides this, there is a large local business done by tugs with scows, booms, etc., transporting lumber, charcoal, cord wood, hay, etc., and towing rafts of logs and timber between points around Portage Lake and Torch Lake, amounting in value to about $1,000,000. There are also local steamers plying between towns along Portage Lake that are not expected to make any reports unless they use Portage River or the Upper Canal.

TRANSPORTATION LINES.

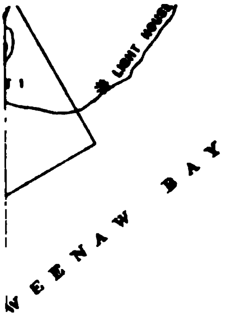
Some of the principal lines of vessels using these canals for the season of 1900 and up to the present are as follows:

The Lake Michigan and Lake Superior Transportation Company, Chicago, Ill	4
The Erie and Western Transportation Company (Anchor Line), Buffalo, N. Y	14
The Western Transit Company, Buffalo, N. Y	14
The Union Transit Company, Buffalo, N. Y	5
James Davidson, Bay City, Mich	15
M. Sicken, Marine City, Mich	9
Hines Lumber Company, Chicago, Ill	14
F. W. Gilchrist, Alpena, Mich	6
Soper Lumber Company, Chicago, Ill	3
Duluth and Atlantic Transportation Company, Cleveland, Ohio	2
A. Booth & Co., Duluth, Minn	2
White Line Transportation Company, Duluth, Minn	2

The above table gives only some of the principal transportation lines that are using these canals regularly. Besides these there are many vessels belonging to other lines and to individuals, and many large steel steamers and barges, some of them towing several vessels or barges, which use this route frequently. The business of tugs towing vessels, rafts, scows loaded with stone, wood, lumber, etc., through these canals is also quite large.

Summary of expenditures made from appropriation for operating and care of canals and other works of navigation (indefinite), act of July 5, 1884, applied to Portage Lake and Lake Superior canals during fiscal year 1901.

Date.	Office expense.	Field service.	Miscellaneous.	Dredging.	Total.
1900.					
August	$242.00	$597.00	$153.22		$992.22
September	19.00		5.00		24.00
October	204.00	221.00	125.56		550.56
November	152.00	274.00	106.70		532.70
December	127.00	418.00	19.47		564.47
1901.					
January	114.00	78.00			192.00
February	102.00	78.00			180.00
March	114.00	98.00			212.00
April			60.80		60.80
May	204.00	539.50			743.50
June	132.00	264.55	1.20	$3,850.00	4,247.75
Total	1,410.00	2,568.05	471.95	3,850.00	8,300.00



THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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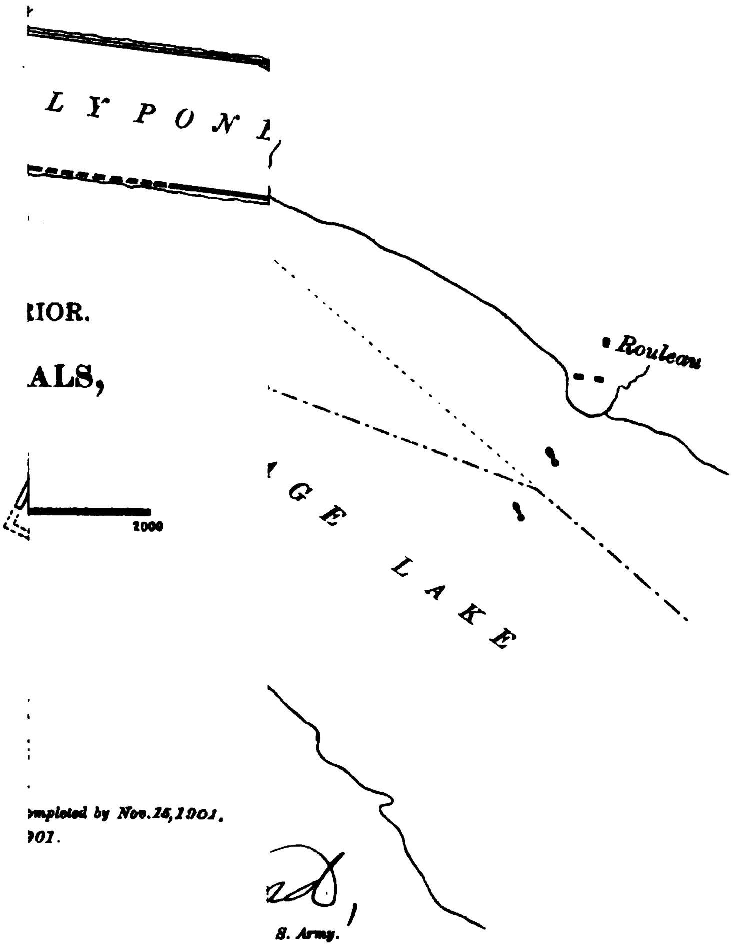

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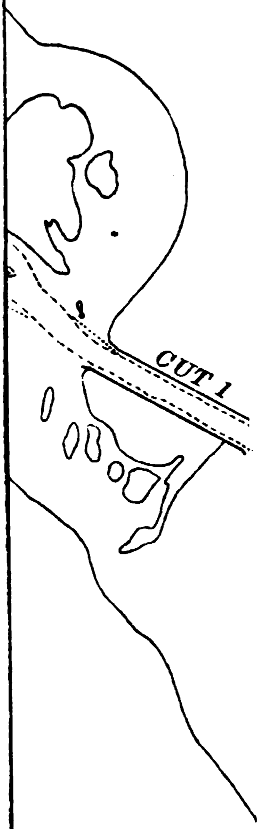

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Engineers, U S. Army.

K K 7.

IMPROVEMENT OF HARBOR AT MARQUETTE, MICHIGAN.

Originally this harbor was entirely unprotected from northeast storms.

Projects were adopted in 1868 and 1888 for the erection of a breakwater, composed of timber cribs ballasted with rock, extending from the shore into the bay a distance of 3,000 feet. This breakwater was completed, practically as proposed, in 1894, at a total cost of $469,732.44, including repairs.

Owing to the general decay of a large portion of the original superstructure and the certainty that the whole of it would have to be renewed every twenty or twenty-five years, a project for a concrete superstructure for the whole breakwater was approved February 27, 1890. This project was estimated to cost $232,936.71.

Of this concrete superstructure 1,500 linear feet have been constructed and 76 concrete footing blocks have been built, ready for future extensions. (For detailed description of this work, with drawings, cost, photographic views, etc., see the annual reports, 1896, pages 2365–2385; 1897, pages 2615–2638, and 1898, pages 2252–2282.)

The amount expended on this harbor up to June 30, 1900, is $557,492.12, of which $87,759.68 was under the present project. The results have been the complete protection of the ore, coal, lumber, and commercial docks from storms, and have demonstrated the stability and permanency of the concrete superstructure.

The concrete work was all done by day labor and materials purchased by contract after due advertisement.

No construction work was in progress during the fiscal year ending June 30, 1901.

Owing to the shortness of the working season during which concrete can be laid safely—only five months—it is very desirable to have an appropriation large enough to keep up work with a full force throughout at least two working seasons.

During the fiscal year ending June 30, 1872, there were 780 arrivals and clearances of vessels, with a registered tonnage of 370,000 tons.

In 1900 there were 2,060 arrivals and clearances, with a registered tonnage of 2,776,953 tons. In twenty-three years the commerce of the port has amounted to at least $105,000,000.

Name of harbor, Marquette Harbor, Michigan. Collection district, Marquette, Mich. Nearest light-house, Marquette, Mich.

Money statement.

July 1, 1900, balance unexpended		$1,066.57
June 30, 1901, amount expended during fiscal year		528.35
July 1, 1901, balance unexpended		538.22
Amount (estimated) required for completion of existing project		100,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901:		
For works of improvement	$60,000.00	
For maintenance of improvement	3,000.00	
		63,000.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

Abstract of appropriations for improving harbor at Marquette, Mich.

By act of Congress—		By act of Congress—	
Approved March 2, 1867 (allotment)	$85,000.00	Approved July 5, 1884	$5,000.00
Approved April 10, 1869 (allotment)	26,730.00	Approved August 5, 1886	10,000.00
Approved July 11, 1870	25,000.00	Of August 11, 1888	25,000.00
Approved March 3, 1871	60,000.00	Approved September 19, 1890	40,000.00
Approved June 10, 1872	50,000.00	Approved July 13, 1892	80,000.00
Approved March 3, 1873	15,000.00	Of August 18, 1894	30,000.00
Approved June 23, 1874	15,000.00	Passed June 3, 1896	29,000.00
Approved March 3, 1875	15,000.00	Deposited in United States Treasury January 28, 1896	327.76
Approved June 18, 1878	2,000.00	July, 1898, repayment	.93
Approved August 14, 1878	2,000.00	Of March 3, 1899	25,000.00
Approved March 3, 1879	1,500.00		
Approved June 14, 1880	1,000.00		
Passed August 2, 1882	16,000.00	Total	558,558.69

COMMERCIAL STATISTICS, MARQUETTE, MICH.

Arrivals and clearances, 1892–1900.

	Arrivals.	Clearances.	Tonnage.
1892	782	788	1,474,002
1893	661	661	594,900
1894 (steam, 660; sail, 256)	916	916	900,306
1895 (steam, 543; sail, 254)	797	797	915,800
1896 (steam, 692; sail, 340)	1,032	1,032	1,586,184
1897 (steam, 482; sail, 249)	731	716	1,577,111
1898 (steam, 710; sail, 308)	1,018	1,018	1,178,468
1899 (steam, 1,089; sail, 290)	1,379	1,373	3,427,908
1900 (steam, 655; sail, 369)	1,024	1,036	2,776,958

Beginning with 1899, includes line boats which do not report at custom-house and have not been included before.

Principal articles of exports and imports, 1900.

Exports.	Tons.	Imports.	Tons.
Iron ore	2,495,397	Coal	224,658
Pig iron	6,550	Salt	1,110
Stone	450	Railroad iron	1,100
Lumber	166,255	General merchandise	5,448
Railroad iron	50	Oil	32,000
General merchandise	4,040		
Total exports	2,672,742	Total imports	264,316

Total exports and imports, 2,937,058 tons.

Vessel tonnage.

Year.	Tonnage.	Average tonnage.
1899	3,427,908	1,246
1900	2,776,958	1,334
Decrease	650,950	....
Increase	....	88

Comparative statement of receipts and shipments.

	Tons.
1896	1,832,061
1897	2,529,518
1898	2,491,467
1899	2,919,339
1900	2,937,058

K K 8.

HARBOR OF REFUGE, MARQUETTE BAY, MICHIGAN.

This work was ordered by the act of June 3, 1896.

For the description of the locality and the interests to be benefited by the improvement see Annual Report of the Chief of Engineers, U. S. Army, 1896, pages 2385, 2386.

The approved project is for the construction of a breakwater 1,000 feet in length on the reef running out from Presque Isle Point in a general southeast direction. This protects the ore and commercial docks of the Lake Superior and Ishpeming Railway Company and the docks of the Dead River Lumber Company.

This breakwater was completed to its full length in July, 1900, with the appropriation of $30,000 made in the act of March 3, 1899.

As extra work, a decked crib 50 by 24 by 5 feet 6 inches was built and sunk in 1897 at the inner end of the breakwater and extending toward shore, to break the effect of the waves rolling through the gap between the shore and inner end of the work.

The main work has a slope to the waves from +0.5 foot (L. W. D.) on the outside to +10 feet on the inner side, the width being 24 feet.

An inspection made in May, 1901, shows the entire work to be in excellent condition, although some erosion of the shore in the vicinity has been caused by waves and currents passing through the gap between the breakwater and the shore.

Total expended to June 30, 1900, $31,205.64.

Money statement.

July 1, 1900, balance unexpended	$18,794.36
June 30, 1901, amount expended during fiscal year	17,957.27
July 1, 1901, balance unexpended	837.09

Abstract of appropriations for harbor of refuge, Marquette Bay, Michigan.

Act of Congress—	
Passed June 3, 1896	$20,000
Approved March 3, 1899	30,000
Total	50,000

COMMERCIAL STATISTICS.

Receipts and shipments, 1900.

Shipments.	Tons.	Receipts.	Tons.
Iron ore	1,510,163	Coal	53,815
Lumber, 9,000,000 feet	14,625		
Total	1,524,788		

Receipts and shipments for five years.

	1896.	1897.	1898.	1899.	1900.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Receipts	8,523	27,918	36,096	48,519	53,815
Shipments	339,258	1,067,330	1,118,989	1,427,268	1,524,788
Total	347,781	1,095,248	1,155,085	1,475,787	1,578,603
Increase 1900 over 1899					102,816

Arrivals and departures of vessels for two years.

	Arrivals.	Departures.	Total.
1900	524	524	1,048
1899	583	583	1,166
Decrease	59	59	118

Approximate value of commerce.

1896	$765,000
1897	2,410,000
1898	2,500,000
1899	3,250,000
1900	3,418,898

K K 9.

IMPROVEMENT OF HARBOR OF REFUGE AT GRAND MARAIS, MICHIGAN.

Originally the harbor of Grand Marais, Mich., was accessible only for vessels drawing less than 9 feet. Once within the bay there is ample depth to float the largest vessels. As a harbor of refuge it is of importance to the shipping navigating the lakes in this vicinity.

The project for the improvement of this harbor was adopted in 1881. It provides for parallel piers, 500 feet apart, to extend from high water mark to a depth in the lake of 22 feet at ordinary low water. Through the spit and between these piers a channel to be dredged having a width of 300 feet and a depth of 18 feet at ordinary low water at its harbor end, and a width of 500 feet and a depth of 20 feet at its lake end, where it reaches the 20-foot curve.

The west pier is now 1,656 feet long, including 100 feet of pile dike, and the east pier 1,153 feet long, including 100 feet of pile dike.

A careful and comprehensive survey made in the fall of 1894 showed, when compared with previous surveys, that the harbor was slowly but surely filling up by the sand rolled in by the waves through the interval of 5,700 feet between the east pier and the eastern shore.

This fact necessitated an amendment of the project by providing for a close pile dike across this open interval. This was approved by the Chief of Engineers December 21, 1894.

A channel 150 feet wide and 17 feet deep was dredged out between the piers in 1889.

An examination made in June, 1890, showed considerable shoaling, and in 1891 it was again dredged, this time to a width of 175 feet and a least depth of over 17 feet. A partial survey made in June, 1893, showed a shoaling to 14 feet, principally opposite the portion of the west pier which extends beyond the east pier, so that with any swell on it would not be safe to bring in a vessel of more than 12 feet draft.

An examination made in June, 1894, showed that there was a least depth of 15.5 feet along the channel, and this, as before, opposite the west pier where it extends beyond the east pier. An examination made in May, 1900, showed a least depth of about 14 feet.

The pile dike, 5,700 feet long from the east pier to the easterly shore, completed in 1897 to fence off the sand banks which were gradually encroaching on the deep water of the harbor, is in good condition, except in two places aggregating about 150 feet in length, where minor repairs are needed. It is being gradually strengthened by sand accumulating against it. The protection afforded by it to the bay behind it has been extensively utilized for the booming and storage of logs.

The act of March 3, 1899, appropriated $25,000 for continuing the improvement of this harbor. Ten thousand dollars of this was expended in 1899 in repairs to the piers under contract, after due advertisement, and the balance was expended in 1900 in extending the east pier 200 feet. To give the foundation full time to settle into final position before putting on the superstructure four 50-foot cribs were sunk in extension of the east pier and decked over temporarily. After final settlement the decking over the open pockets will be removed and the superstructure put on under a future appropriation.

The amount expended on the above project as amended in 1894, up to the close of the fiscal year ending June 30, 1900, was $314,989.27.

An allotment of $500 was made from the appropriation for "Emergencies in river and harbor works" (act of June 6, 1900) for repairs to the west pier. The repairs were made under oral agreement during October, 1900, by Powell & Mitchell, the contractors, on the pier extension at that time, at a total cost of $348.32, and the balance of the funds returned to the Treasury.

To serve as a proper harbor of refuge for all classes of vessels, the entrance should have a safe navigable depth of 20 feet throughout.

The sand about Grand Marais shifts extensively, and to secure the depth called for in the present project the piers should be fully and rapidly extended to the 22-foot curve, and a channel dredged out between the piers. To preserve this channel it is quite probable that dredging will have to be done annually or biennially.

Estimated cost of project.

Original estimate (see Report of Chief of Engineers, 1881, p. 2053)	$450,000
Modified by authority of Chief of Engineers, December 21, 1894, to include pile dike.....	34,000
Total	484,000
Appropriated	330,598.32

The commerce of this place has increased from 1,910 tons in 1887 to 135,756 tons in 1900.

This work is in the collection district of Superior, Mich.; nearest port of entry, Marquette, Mich.; nearest light-house, Grand Marais, Mich.

Money statement.

July 1, 1900, balance unexpended	$15,260.73
June 30, 1901, amount expended during fiscal year	[1] 15,253.95
July 1, 1901, balance unexpended	6.78

Amount (estimated) required for completion of existing project		153,401.68
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901:		
For works of improvement	$100,000.00	
For maintenance of improvement	5,000.00	
		105,000.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

Abstract of appropriations for improving harbor of refuge at Grand Marais, Mich.

By act of Congress—	
Approved June 14, 1880	$10,000.00
Approved March 3, 1881	20,000.00
Passed August 2, 1882	40,000.00
Approved July 5, 1884	35,000.00
Approved August 5, 1886	26,250.00
Of August 11, 1888	50,000.00
Approved September 19, 1890	50,000.00
Approved July 13, 1892	$30,000.00
Of August 18, 1894	20,000.00
Passed June 3, 1896	24,000.00
Approved March 3, 1899	25,000.00
Allotted from act June 6, 1900	348.32
Total	330,598.32

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels at Grand Marais, Mich.

Year.	Steam vessels.		Sailing and towing vessels.		Total arrivals.	Clearances.
	Number.	Tonnage.	Number.	Tonnage.		
1892	155				155	155
1893	187	26,645	11	10,000	198	197
1894	160	69,300	3		a 193	192
1895	219	78,000	44	26,800	263	261
1896	224	210,000	104	100,000	328	328
1897	287	300,000	117	200,000	404	403
1898	310	345,000	125	250,000	435	435
1899	302	330,000	130	170,000	432	432
1900	336	290,800	98	120,400	429	428

a Includes 30 barges.

Principal articles of export and import.

Exports.	Tons.	Imports.	Tons.
Lumber and logs	117,556	Merchandise	6,000
Shingles	3,000	Coal	3,650
Lath	3,100	Hay	1,000
Fish	250	Oats	1,200
Total	123,906	Total	11,850
Valuation	$987,000	Valuation	$639,000

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[1] In addition $348.32 were expended on repairs to west pier allotted from act June 6, 1900.

Receipts and shipments for fourteen years.

Year.	Tons.	Year.	Tons.	Year.	Tons.
1887	1,910	1892	5,020	1897	142,536
1888	6,270	1893	35,450	1898	103,825
1889	8,686	1894	39,250	1899 (not including logs)	116,050
1890	9,405	1895	56,208	1900 (including logs)	135,756
1891	1,356	1896	90,497		

Approximate value of commerce.

1896	$691,650
1897	1,380,675
1898 (including logs)	1,431,500
1899 (not including logs)	1,735,500
1900 (including logs)	1,626,000

K K 10.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

The steam tug *E. P. Ferry*, belonging to Messrs. King & Steele, of Duluth, Minn., was burned in Duluth Harbor on the night of January 18–19, 1900. While burning the tug was towed to Minnesota Point and grounded on the bottom, about 120 feet north of the Marvin street city ferry landing and about 160 feet from shore, where it burned to the water's edge. During the season of 1900 the boiler and engine were removed. In the storm of May 23, 1901, the wreck drifted about 20 feet farther into the bay, where it now lies under water of a general depth of about 10 feet. The tug had a wooden hull, and her registered dimensions were: Length, 67 feet; breadth, 15 feet; depth, 7.6 feet. She was built in 1873, and her owners state that they have abandoned the wreck. The wreck lies directly in the path of the city ferry, and is a menace to navigation in this vicinity.

By letter from office of Chief of Engineers, dated June 12, 1901, an allotment of $500 was made for removing the wreck. Under authority of this indorsement, public notice will be given, and the proposal of the lowest responsible bidder will be accepted, provided it comes within the limits of the appropriation.

K K 11.

NOTES BY J. H. DARLING, ASSISTANT ENGINEER, ON ROCK FOUND IN VICINITY OF DULUTH, MINN.

United States Engineer Office,
Duluth, Minn., June 22, 1901.

Captain: I have the honor to hand you the following notes relating to rock found in this vicinity, used for riprap, etc.

Very respectfully, your obedient servant,

J. H. Darling,
Assistant Engineer.

Capt. D. D. Gaillard,
Corps of Engineers, U. S. A.

NOTES ON WEIGHT OF RIPRAP.

This paper is designed to show the relative stability of rocks of different densities, and, in particular, the relative sizes of two blocks of different densities for equal stability. Also to give a list of some of the rocks around the head of Lake Superior whose specific gravity has been determined.

RESISTANCE TO OVERTURNING.

Some theoretical relations will here be stated pertaining to cubical blocks, which are of simplest form.

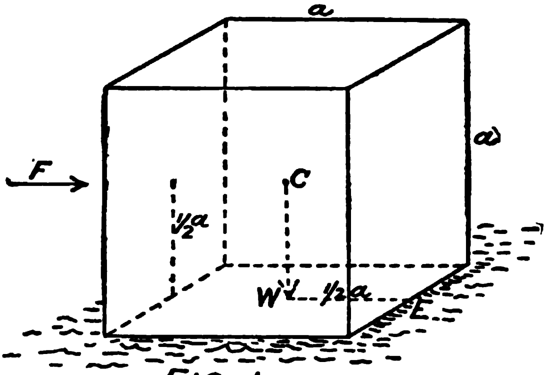

FIG. 1.

This figure represents a cube, with length of each edge=a, in feet; density p= weight per cubic foot; Weight $W=pa^3$; C=Center of gravity; E=line of overturning; F=overturning force; moment of stability=$W\frac{1}{2}a=\frac{1}{2}pa^4$ in foot-pounds.

A force F sufficient to overturn the block may be taken as the resultant of a unit force f in pounds per square foot acting against a vertical side, such as from running water or a wave striking against it. $F=fa^2$. When F balances the resistance W it will follow from principle of moments that $F\frac{a}{2}=W\frac{a}{2}$ and, by substitution, $\frac{1}{2}fa^3=\frac{1}{2}pa^4$. Therefore

$$f=pa \qquad (1)$$

and

$$a=\frac{f}{p} \qquad (2)$$

For a cubical block of another kind of rock having a density p_1 its size to resist overturning from the same unit pressure f will be represented by a_1 feet on each edge, and

$$a_1=\frac{f}{p_1} \qquad (3)$$

From (2) and (3) it follows that—

$$\frac{a}{a_1}=\frac{p_1}{p} \qquad (4)$$

and

$$\frac{a^3}{a^3_1}=\frac{p^3_1}{p^3} \qquad (5)$$

a^3 and a^3_1 being the respective volumes.

Hence the volumes of two cubes of different densities but equal stability are inversely proportional to the cubes of their densities.

Also,

$$a^3_1=\left(\frac{p^3}{p_1}\right)a^3 \qquad (6)$$

represents the size of the second piece of rock in order to be of equal stability with first piece.

For example, the force required to overturn, in air, a granite block of cubical form

5 feet on a side, 125 cubic feet in volume, and weighing 170 pounds per cubic foot, is from (1) 850 pounds per square foot. For a lighter rock, say sandstone weighing 140 pounds per foot, to resist overturning from the same unit force, the cube would have to be 6.07 feet on a side and 224 cubic feet in volume, as appears from (3) and (6).

Again, when immersed in water the rock loses 62 pounds in weight per cubic foot, so that granite of 170 pounds will weigh but 108 pounds, and a cubical block of 125 cubic feet will, by (1), be overturned by unit force of 540 pounds per square foot, while the above-mentioned sandstone of 140 pounds in air will weigh 78 in water, and to resist the force of 540 pounds per square foot would have to be 6.92 feet on a side and contain 331 cubic feet, or 2.65 times the size of the granite.

It also appears from (1) that the force required to overturn cubes of the same size but of different material is directly proportional to the densities of the materials, or to their net weights if immersed in water. For example, two cubes of 125 cubic feet each, or 5 feet on a side, one of 170 pounds and the other of 140 pounds, would, if immersed in water, require 540 pounds and 390 pounds per square foot, respectively, to overturn, the latter being 0.72, or about three-fourths the former.

For different sizes of cubes of the same material, the force per unit of surface to overturn is proportional to the linear dimensions. This appears from equation (1). Thus, a cube of 4 feet on a side will stand twice as much pressure per square foot as one of 2 feet on a side.

All the foregoing relations and comparisons between cubical blocks of different sizes and densities hold true of similar polyhedrons similarly placed with respect to the forces acting upon them, as may be shown by analogous reasoning, and likewise in an approximate way to rock broken up into riprap or rubble by blasting, in which there is a general similarity among the pieces of different sizes, and for different kinds of rock.

Blocks deposited in a pile or embankment support each other by their contact, and partially protect each other from exterior forces, so that each will stand a greater unit force before overturning than a single isolated block would of same size.

The expressions already given for relative stability of isolated pieces of similar form but of different densities may be taken as applying in a roughly approximate way to riprap loosely piled, and less accurately to pieces closely piled. For pieces fitted together, as in a pavement or as in one of the types of breakwater now under construction at Buffalo, the advantage of heavy rock over light rock would be diminished.

RESISTANCE TO SLIDING.

Referring to fig. 1, let c=coef. of friction—that is, the ratio of the resistance to sliding to the weight—p=density=weight per cubic foot; W=weight=pa^3; f=unit pressure=pounds per square foot; resistance to sliding=$cW=cpa^3$; force tending to produce movement=$F=fa^2$.

At point of sliding taking place, cW must equal F and $cpa^3=fa^2$.

Therefore

$$F=cpa \tag{7}$$

and

$$a=\frac{f}{cp} \tag{8}$$

For a cube of another kind of rock, of density p_1 and of length of side a_1 to just resist sliding from same unit force

$$a=\frac{f}{cp_1} \tag{9}$$

From (4) and (5) it follows that—

$$\frac{a}{a_1}=\frac{p_1}{p}$$

and

$$\frac{a^3}{a^3_1}=\frac{p^3_1}{p^3} \tag{10}$$

Hence the volumes of two cubes of different densities but of equal stability against sliding are inversely proportional to the cubes of their densities.

It will be noticed that this theorem is identical with that already found to apply to the overturning. Hence the same relations exist between blocks of similar form but of different size or different densities with respect to sliding as to overturning.

OVERTURNING COMPARED WITH SLIDING.

For a given cube of any material we may compare the overturning unit force f in equation (1), with the force required to produce sliding, f_1 in (7). For this purpose we may consider a and p and f constant and f_1 the dependent variable. Dividing (7) by (1) there results

$$\frac{f_1}{f}=c$$

and

$$f_1=cf \tag{11}$$

From this it follows that when the coefficient of friction is less than unity a cube will slide rather than overturn, and if c is greater than unity the block will overturn instead of sliding. The value of c depends on the roughness of the block and the character of the bottom on which it rests. It may vary from 0.25 to 1.11 or more. (See Rankine's Civil Engineering, p. 172.)

If the block is not a cube, the question as to whether it will overturn or slide will depend on the form as well as the coefficient of friction, which face is downward, and the height of the center of gravity above the base with respect to the area of the base.

TABLE 1.—*Table of relative sizes of rocks of different densities to give equal resistance to overturning or to sliding.*

FROM EQUATION (6).

Weight per cubic feet in air.	Relative sizes when in air.	Relative sizes when in water.
180 pounds	1	1
170 pounds	1.2	1.3
160 pounds	1.4	1.7
150 pounds	1.7	2.4
140 pounds	2.1	3.4
130 pounds	2.6	5.3

Thus, rock 130 pounds per cubic foot, if used for riprap under water, would need to be in pieces more than five times as large as those of 180 pounds granite in order to stand as well.

FAILURE OF SANDSTONE RIPRAP.

Observed data in regard to stability of riprap on works of harbor improvement in this district are quite meager. There have been several instances where sandstone has been used for riprap below water (on account of its cheapness) and failed to stay in place.

One case was at the Wisconsin entrance to Superior Bay. Here sandstone riprap of 150 pounds per cubic foot, from Fond du Lac, near Duluth, in pieces averaging about 22 cubic feet, was placed in 1896 at several points at base of south pier, in channel, the top of the embankment being at a depth of 8 feet below low-water datum. The most exposed locality where this rock was placed was 50 to 200 feet from outer end of pier. Here within a year the riprap was moved and scattered by the waves or currents, probably the former, until the embankment was lowered from 3 to 6 feet. The waves from northeast storms have a fetch of more than 100 miles, and run lengthwise of the pier and embankment, and therefore do not break against the pier at this point.

Granite riprap of 180 pounds per cubic foot was afterwards (in 1897–1898) placed here and has remained undisturbed. The comparison between the granite and sandstone at this point is not conclusive, as the granite was in larger pieces, about twice the size of the sandstone, though on the other hand it was carried up nearer to the surface of the water—that is, about 7 feet from low-water datum, and therefore subject to greater wave force.

The same kind of sandstone riprap as just described placed alongside the same pier 300 feet farther in toward the harbor was moved to a less extent, and still less at a point 1,000 to 1,400 feet from the lake end of the pier, as the force of the waves became reduced.

At the lake end of the old south pier or jetty of the Duluth Canal there was placed in 1892 a quantity of sandstone riprap. I find no record of this, but learn from Mr. E. H. Foster, United States Inspector of that work, and from J. H. Crowley, a prominent dealer in rock, who saw this rock, that it consisted of one large scow load of dimension sandstone from Cranberry River. These pieces were, some of them, as large as 100 and 125 cubic feet, and would probably average 80 or 90 cubic feet, and were pulled off the scow by a tug, one piece at a time, into the water.

Most of this sandstone disappeared. Mr. T. Mackey, who dredged out the old pier and riprap in November and December, 1900, stated in regard to the riprap at the lake end of the pier, that there were about 12 cords of pieces too large to go through the dipper. About twice this amount was smaller rock, which was dropped through the dipper into the dump scow. The 12 cords of larger pieces averaged about 27 or 30 cubic feet in size. There were two pieces of about 50 or 60 cubic feet. Of the larger pieces, a few, not more than 5 or 6, were sandstone, the remainder granite. He had been told that there had been a large quantity of the larger pieces of sandstone placed there, but it did not show up.

Here, then, was granite riprap in pieces of 27 or 30 cubic feet, probable weight about 175 pounds per cubic foot, along with sandstone of 80 to 90 cubic feet and probable weight about 135 pounds per cubic foot (132 pounds when partly dry, as per Table 2). According to Table 1 this sandstone should be in pieces four times as large as the granite for equal stability, but was only three times as large, and therefore less stable than the granite, according to theory. So it might be displaced while the granite remained.

It should be said, however, that this sandstone was a soft variety, and it is possible that it was worn away by storms during those eight years, instead of being displaced or worn to a smaller size and then displaced.

It may be further questioned whether the form of these sandstone dimension blocks, which was rectangulur, was as favorable for stability, when a lot of them was thrown into the water at random, as riprap, as was the angular, irregular shape of the granite riprap.

The top of the riprap next to the pier was recently 9 to 12 feet below low water; high water in storms about 2 feet more. The slope of the riprap was about 1 vertical to 2 horizontal.

The pier end presented a flat vertical face, perpendicular to the severest storms, 38 feet wide, and from 11 feet above low water down to the riprap. As spray has often been thrown to a height of 60 feet or more by waves dashing against this pier, the reactive force on the riprap must have been considerable.

Following is a brief description of some of the rocks found around the western portion of Lake Superior, and quarried for building stone or rubble, crib filling, and riprap, as tested for weight by the writer and others under this office, with reference to its suitableness for pier work.

For determining density the following formula was used:

$$\text{Weight per cubic foot} = 62.5 \frac{W}{W\text{-}w}$$

in which W and w are weights in air and water, respectively.

The granite in Table 2 is dark colored, with fine homogeneous texture. It is heavier than most of the granite used for building purposes found in other parts of the country.

TABLE 2.—*Rocks from western Lake Superior.*

Location.	Description.	Degree of moisure. a	Authority.	Date.	Number of samples tested.	Weight per cubic foot in air (mean of samples).
	Sandstone:					*Pounds.*
Portage entry, Keweenaw Point, Michigan.	Fine grain and uniform. Red, used for building stone and riprap.	Dry	J. H. Darling	Aug. —, 1897	1	136
		Wet	do	do	8	146
		Not stated	M. W. Lewis	Sept. —, 1897	2	141
Presque Isle, Wisconsin, 75 miles from Duluth.	Dense and uniform.	Dry	do	do	8	138
Cranberry River, Wisconsin, 40 miles from Duluth.	Soft and coarse	do	J. H. Darling	Aug. —, 1897	1	132
Iron River, Wisconsin, 29 miles from Duluth.	First 4 samples soft to fairly hard.	Wet	do	do	4	139
		Green	M. W. Lewis	Sept. —, 1897	2	147
Fond du Lac, Wis.: 14 miles from Duluth, on St. Louis River. Duluth Brownstone Co. C. A. Krause's quarry.	Strong and durable.	Dry	J. H. Darling	Aug. —, 1897	8	147
		Wet	do	do	5	151
		Green	M. W. Lewis	Sept. —, 1897	2	149
Kettle River, Minnesota.	Very hard, fine grained, and durable.	Dry	J. H. Darling	Aug. —, 1897	1	147
		Green	M. W. Lewis	Sept. —, 1897	2	142
		Not stated	do	do	5	145

a Dry=apparently dry but exposed to weather. Green=recently quarried. Wet=water soaked.

TABLE 2.—*Rocks from western Lake Superior*—Continued.

Location.	Description.	Degree of moisture.	Authority.	Date.	Number of samples tested.	Weight per cubic foot in air (mean of samples.)
	Granite:					*Pounds.*
Duluth, Smithville, on line of St. Paul and Duluth R. R.	Dark colored, fine grained. 3,200 tons of this was placed for riprap at base of south pier Superior entry, in fall of 1897.		M. W. Lewis, J. H. Darling.	Sept.—, 1897 Oct. —, 1897	5	180
Duluth, Fifty-eighth avenue W. on line Duluth, Mesabec and Northern R. R.	Not used on United States work.		M. W. Lewis	Sept.—, 1897	1	174
Duluth, Sixteenth avenue W. and First street.	Used for crib filling in repairs to south pier at Superior entry.		J. H. Darling.	Oct. —, 1897	2	178
Duluth, Eighth avenue W. and Superior street.	Used for crib filling in new north pier, Duluth Canal, cribs 1 to 13, underfilling and riprap. In this quarry was a horizontal layer of red trap, mean of 2 samples 161 pounds, making about 6 per cent of total used. Mean weight of rock in pier therefore 175.1 pounds.		A. A. Sinclair.	Mar.—, 1900	1	177
				June—, 1900	2	177
				Dec. —, 1900	3	176
				Mean	6	176
Duluth, Twenty-fifth avenue E. and lake shore.	Used as crib filling for new south pier, Duluth Canal, cribs 1 to 5.		J. H. Darling	May 31, 1898 June 3, 1898	12	171
			W. H. Hoyt	May 30, 1899	4	167
Duluth, Twenty-fourth avenue E. and lake shore.	Used as crib filling for new south pier, Duluth Canal, cribs 6 to 17.		W. H. Hoyt	May 30, 1899 June 2, 1899	7	166
	Trap:					
Duluth, Seventh avenue W.	Bidder's sample; not used by United States.		M. W. Lewis	Sept. —, 1897	1	168
	Granite:					
Sucker River, north shore of lake, 1 mile west of Sucker River, 14 miles from Duluth.	Contractor's samples; not used.		A. A. Sinclair	May 29, 1899	8	181
Stony Point, north shore of lake, 18 miles from Duluth.	Used for riprap at Superior entry.		M. W. Lewis	Mar. —, 1898	2	176
			E. H. Spalding	June —, 1898	4	182
				Mean of	6	180
	Trap:					
Stony Point	Not used		M. W. Lewis	Mar. —, 1898	1	158
	Granite:					
Knife River, north shore of lake, 1 mile east of Knife River, 21 miles from Duluth.	Used for crib filling and underfilling, new north pier, Duluth Canal, cribs 14 to 17.		A. A. Sinclair	May 29, 1899	6	172
			do	July 11, 1899	2	173
			do	July 27, 1899	4	170
			do	Aug. 2, 1899	2	175
			do	Sept. 22, 1899	8	174
			do	Oct. 28, 1899	4	173
			do	Nov. 22, 1899	8	176
				Mean of	24	173

TABLE 2.—*Rocks from western Lake Superior*—Continued.

Location.	Description.	Degree of moisture.	Authority.	Date.	Number of samples tested.	Weight per cubic foot in air (mean of samples).
						Pounds.
Silver Creek, North shore of lake, 5 miles east of Two Harbors, Minn.	Used for riprap at Superior entry.	....	E. H. Spalding	June —, 1898	9	182
			....do........	July —, 1898	3	183
			....do........	Sept. —, 1898	12	182
			....do........	Aug. —, 1899	8	175
				Mean of...	32	180
	Trap:					
Silver Creek.......	Not used........	....	....do.........	June —, 1898	2	173
Grand Marais, Minn., north shore of lake, 110 miles from Duluth, 200 feet west of harbor entrance.	....	....	A. A. Sinclair.	May —, 1901	5	185
Grand Marais, Minn., 400 feet east of harbor entrance.	Last two used for crib filling, and part of embankment for west breakwater.	....	....do.........	....do.......	3	179
	Dark rock:					
Hancock, Mich., on shore of Portage Lake, 2 miles west of Hancock.	Hard, close grained, dark colored. Proposed by Mr. Marr, for breakwater at upper entrance.	....	....do.........	Dec. —, 1900	1	165
	Trap:					
Good Harbor Bay, 6 miles west of Grand Marais, Minn.	Hard. Used for riprapping embankment of east 200 feet of west breakwater, Grand Marais, Minn.	....	....do.........	June —, 1901	4	190
	Various:					
Grand Marais, Minn.	Bowlders dredged up from harbor. Used for crib filling in east 200 feet west breakwater.	....	....do.........	....do.......	4	191
	Trap:					
Grand Marais, Minn., new quarry about 1,600 feet east of entrance and north side of point in lake.	For crib filling in east 200 feet of west breakwater.	....	....do.........	....do.......	4	190

K K 12.

EXAMINATION AND SURVEY OF BURLINGTON BAY, MINNESOTA.

[Printed in House Doc. No. 114, Fifty-sixth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS, UNITED STATES ARMY,
Washington, December 4, 1900.

SIR: I have the honor to submit herewith copies of reports, dated August 13, 1900, and November 10, 1900, by Maj. Clinton B. Sears, Corps of Engineers, upon the results of preliminary examination and survey, respectively, authorized by the river and harbor act approved June 6, 1900, of Burlington Bay, Lake County, Minn., "with a view to improving said bay and the construction of a harbor therein."

The plan of improvement presented by Major Sears provides for the construction of a breakwater at an estimated cost of not to exceed $435,000, which amount the local officer states may be reduced 10 per cent if the work be carried out under the continuing contract system. Alternate estimates and locations for the breakwater are given in the report of November 10, 1900, but the opinion is expressed that its exact length and location may well be left for future consideration.

In this connection attention is invited to the views of the division engineer, Col. J. W. Barlow, Corps of Engineers, in his indorsement of November 26, 1900, as follows:

> The value and importance of this improvement is undoubted; but since it would appear that the pecuniary benefits resulting therefrom will accrue to a single corporation, it is questionable whether this work should be considered of such national importance as to warrant its being undertaken by the United States Government.

Very respectfully, your obedient servant,

John M. Wilson,
Brig. Gen., Chief of Engineers,
U. S. Army.

Hon. Elihu Root,
Secretary of War.

PRELIMINARY EXAMINATION OF BURLINGTON BAY, LAKE COUNTY, MINN., WITH A VIEW TO IMPROVING SAID BAY AND CONSTRUCTING A HARBOR THEREIN.

United States Engineer Office,
Duluth, Minn., August 13, 1900.

General: In compliance with your circular letter of June 13, 1900, and your letter of June 30, 1900, I have the honor to submit herewith my report upon the preliminary examination of Burlington Bay, Lake County, Minn.

In this connection attention is invited to the accompanying report of Mr. J. H. Darling, assistant engineer, which is approved and the recommendations contained therein are concurred in by me.

Burlington Bay is one of the two bays situated at the town of Two Harbors, Minn., the other being Agate Bay, and these bays give the town its name. Agate Bay has already been improved by the Government, the project for its improvement to be completed in 1901. It is limited in size and its capacity is now being fully utilized by the Duluth and Iron Range Railroad Company, making the improvement of Burlington Bay a necessity to meet the growing commercial demands of the port of Two Harbors. Due to the undoubted rapid growth of this commerce in the near future, and to the necessity for further harbor refuge, I deem Burlington Bay worthy of improvement by the Government.

A survey upon which to base a project and estimate may cost $600, though it is hoped to be able to get along with only $400. This amount will have to be allotted from the appropriation made by the act of June 6, 1900, as there are no unexpended balances of former appropriations.

Very respectfully,

Clinton B. Sears,
Major, Corps of Engineers.

Brig. Gen. John M. Wilson,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, NORTHWEST DIVISION,
New York, August 24, 1900.

Respectfully forwarded to the Chief of Engineers, United States Army.

In view of the facts, as shown by the report of the assistant engineer, it would appear that the improvement of Agate Bay has been almost exclusively in the interests of the Minnesota Iron Company, which owns and controls the Duluth and Iron Range Railroad Company.

The estimated cost of the improvements at Agate Bay, already made and proposed, is over $244,000.

The business of this company having reached the limit of protection afforded at Agate Bay, it is now asked of the United States to provide an additional harbor at Burlington Bay, of even greater capacity and larger cost, to protect the same company's prospective increase of business. The plea of a harbor of refuge is also advanced.

There is no present commerce at Burlington Bay, and the prospective commerce as shown by the following quotation from the report of the assistant engineer pertains solely to one corporation:

> The policy of this railroad is not to sell any of the water frontage, but to lease sites to any tenants that will bring business to the railroad, and to build docks for such tenants. It will not lease land or riparian privileges for speculative purposes. The railroad company is backed by the Minnesota Iron Company, a wealthy and powerful corporation, which owns practically all the stock of this railroad.

It therefore does not seem that the prospective interests to be provided for are sufficiently diversified to justify the construction of an additional harbor at the expense of the United States. I, therefore, can not concur in the recommendation of the district engineer, and must state that, in my opinion, Burlington Bay is not worthy of improvement by the United States for the purposes desired.

J. W. BARLOW,
Colonel, Corps of Engineers,
Division Engineer.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
August 30, 1900.

Respectfully submitted to the Secretary of War.

This is a report upon preliminary examination under provisions of the emergency river and harbor act of June 6, 1900, of Burlington Bay, Minnesota, with a view to improving said bay and the construction of a harbor therein.

This bay and Agate Bay are situated at the town of Two Harbors. Agate Bay is already under improvement by the United States, and the project will be completed in 1901. Being limited in size, the capacity of Agate Bay is now fully utilized by the Duluth and Iron Range Railroad Company, which is owned and controlled by the Minnesota Iron Company.

The railroad company is reported as owning the entire shore line of Burlington Bay, including adjoining land for a greater or less distance, and also the shore line and abutting land at Agate Bay; and it is stated that its policy is not to sell any of the water frontage, but to lease sites to any tenants that will bring business to the railroad, and to build docks for such tenants, and that it will not lease land or riparian privileges for speculative purposes. There is no present commerce at Burlington Bay, and the prospective commerce probably pertains principally to this corporation.

The local officer is of opinion, "due to the undoubted rapid growth of this commerce in the near future and to the necessity for further harbor refuge," that Burlington Bay is worthy of improvement by the General Goverment.

The division engineer, for reasons given in the preceding indorsement, to which attention is respectfully invited, expresses the opposite opinion.

Regarding the question of ownership of adjacent property, it would seem that Congress should determine whether or not the conditions are such as to make it proper or improper for the Government to furnish funds for the contemplated improvement, and I recommend, with a view to securing the necessary data to enable Congress to act on the questions presented, that the survey proposed by the local engineer be authorized.

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

[Third indorsement.]

WAR DEPARTMENT,
August 31, 1900.

Approved as recommended by the Chief of Engineers.

ELIHU ROOT,
Secretary of War.

REPORT OF MR. J. H. DARLING, ASSISTANT ENGINEER.

DULUTH, MINN., *August 12, 1900.*

MAJOR: I have the honor to submit the following memoranda relative to a preliminary examination of Burlington Bay, Minnesota.

Very respectfully, your obedient servant,

J. H. DARLING,
Assistant Engineer.

Maj. CLINTON B. SEARS,
Corps of Engineers, U. S. A.

DESCRIPTION OF LOCALITY.

Burlington Bay is on the north shore of Lake Superior, about 28 miles from Duluth, and about 1 mile east of Agate Bay and the town of Two Harbors.

This bay is 1 mile wide and extends into the land 2,800 feet. The water deepens from the inner shore line to 60 feet and more at the entrance. The bottom consists of clay and sand, according to the lake survey detail chart, and of clay with more or less bowlders in different places, according to a report by United States Asst. Engineer Randell Hunt, who made a survey in 1884.

The bay is considerably protected from southwest storms by the point of land lying between it and Agate Bay, but is subject to a wash from that direction. It is open to the south and east, but storms from these directions are very rare. It is partially protected from the northeast by the easterly point of land, but the northeast storms are so severe and the fetch of waves so great that the sea from these storms rolls around into the bay with a good deal of force and renders the bay unsafe for vessels.

This bay is quite similar in size, form, depth of water, and exposure to storms, to Agate Bay. Is some larger. The following areas are given, those for Agate Bay being within the present breakwater, and those for Burlington Bay being within a possible position for a line of breakwater as sketched on a map in this office.

Agate Bay, Minnesota.

	Acres.
Area bounded by breakwater and original shore line	109
Area bounded by breakwater and 10-foot curve of depth	93
Area bounded by breakwater and 15-foot curve of depth	78
Area bounded by breakwater and 20-foot curve of depth	64

Burlington Bay, Minnesota.

	Acres.
Area bounded by a supposed breakwater and the shore line	163
Area bounded by a supposed breakwater and 10-foot curve of depth	130
Area bounded by a supposed breakwater and 15-foot curve of depth	112
Area bounded by a supposed breakwater and 20-foot curve of depth	93

The above figures would make Burlington Bay about 50 per cent larger than Agate Bay for corresponding areas of depth.

Burlington Bay has no commerce. Its shores are unimproved and practically unoccupied. The entire shore line, and adjoining land to a greater or less distance back, is owned by the Duluth and Iron Range Railroad Company, incorporated under the laws of the State of Minnesota, which company also owns the Agate Bay shore line and abutting land. The principal business of this road is the carrying of iron ore, but it does a general freight and passenger business as a common carrier.

The policy of this railroad company is not to sell any of the water frontage, but to lease sites to any tenants that will bring business to the railroad, and to build docks for such tenants. It will not lease land or riparian privileges for speculative purposes. The railroad company is backed by the Minnesota Iron Company, a wealthy and powerful corporation, which owns practically all the stock of this railroad.

PROSPECTIVE COMMERCE.

The prospective commerce of Burlington Bay consists of a proposed enlargement or extension of the business now carried on at Agate Bay and the town of Two Harbors, which is mainly the shipment of iron ore, and the volume of which has now reached the limit of the capacity of that harbor. To judge, then, as to the prospective commerce of Burlington Bay, it will be necessary to review the commercial development of Agate Bay and the Government improvements, and for this purpose the following excerpts from your annual report to the Chief of Engineers for the fiscal year ending June 30, 1900, are given, as bearing directly on the point in question:

"IMPROVEMENT OF HARBOR AT AGATE BAY, MINNESOTA.

"Agate Bay, on which is situated the town of Two Harbors, Minn., is a semicircular harbor of 2,000 feet radius. There is a good navigable depth throughout the greater part of the harbor, but it is exposed to storms from the southwest and from reverse swells of hard storms from the northeast.

"The natural shelter it afforded justified the erection of five extensive ore docks by the Duluth and Iron Range Railroad; also a good commercial dock and a dock for landing coal.

"The rapid increase in the commerce of the harbor caused Congress to undertake its improvement by an appropriation of $22,500 in August, 1886.

"The approved project of 1887 was to construct two breakwater piers."

* * * * * * *

"The original estimate of cost was $213,000, which was increased to $244,208 in Annual Report of 1887 on account of higher prices.

* * * * * * *

"The Act of March 3, 1899, appropriated $71,708 to complete the project for the improvement of this harbor, * * * the contract[1] to be completed by September 1, 1901. Work under this contract is now under way. With the finishing of this work, the project for the improvement of this harbor will be completed.

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[1] Referring to the contract of Powell & Mitchell for building cribs and superstructure of final extension.

"The Duluth and Iron Range Railroad Company has now in successful operation five large ore docks, which, with its commercial dock, utilizes all the available room in the harbor, and any increase in the business of this road must find an outlet elsewhere.

"Of iron there was shipped from this point, during the season of 1899, 4,448,640 tons.

"The total amount expended on this harbor from 1886 to June 30, 1900, has been $180,724.93. During this period of fourteen years, the annual cargo tonnage has increased from 236,000 tons, valued at $524,800, in 1885, to 4,604,252 tons, valued at $9,500,000, in 1899. The total valuation of the cargo tonnage into and out of this port in the fourteen years ending December 31, 1899, is roughly estimated at $40,000,000.

* * * * * * *

COMMERCIAL STATISTICS.

Vessels arriving and departing at Agate Bay, Minnesota.

Year.	Vessels.	Estimated tonnage.	Increase.
1885	174	295,800	....
1886	263	460,000	164,200
1887	465	697,500	237,500
1888	749	1,486,000	738,500
1889	1,255	2,400,000	964,000
1890: Steam, 968 Sail, 82	1,050	2,625,000	225,000
1891: Steam, 1,188 Sail and whaleback, 62	1,250	2,915,000	290,000
1892: Steam, 1,104 Sail, 186 Whaleback, 40	1,330	3,101,600	186,600
1893: Steam, 1,016 Sail, 146 Whaleback, 16	1,178	2,386,200	—715,400
1894: Steam, 1,432 Sail, 116 Whaleback, 70	1,618	3,236,000	849,800
1895: Steam, 1,748 Sail, 350 Whaleback, 396	2,491	4,900,000	1,664,000
1896: Steam, 1,444 Sail, 310 Whaleback, 228	1,982	4,360,000	—540,000
1897: Steam, 1,428 Sail, 334 Whaleback, 302	2,064	6,192,000	1,832,000
1898: Steam, 1,282 Sail, 380 Whaleback, 282	1,944	5,832,000	—360,000
1899: Steam, 1,590 Sail, 550 Whaleback, 326	2,466	7,151,000	1,319,000

Value of freight received and shipped, exclusive of iron ore, $652,478.

Receipts and shipments.

Year.	Ore shipped.	Other freight received and shipped.	Total.	Year.	Ore shipped.	Other freight received and shipped.	Total.
	Tons.	*Tons.*	*Tons.*		*Tons.*	*Tons.*	*Tons.*
1885	225,484	10,895	236,379	1893	902,268	57,616	959,884
1886	304,396	21,954	326,350	1894	1,373,117	66,053	1,439,170
1887	394,252	6,620	400,872	1895	2,139,526	79,004	2,218,530
1888	509,964	30,352	540,316	1896	1,814,186	91,378	1,905,559
1889	924,054	31,731	955,785	1897	2,651,273	79,049	2,730,322
1890	984,215	37,268	1,021,483	1898	2,693,244	118,924	2,812,168
1891	1,000,052	41,181	1,041,233	1899	4,448,640	155,612	4,604,252
1892	1,304,885	54,477	1,359,362				

Estimated value of freight received and shipped (exclusive of ore).

Year.	Amount.	Year.	Amount.
1887	$96,000	1894	$300,000
1888	212,000	1895	220,000
1889	222,000	1896	378,000
1890	246,000	1897	323,000
1891	225,000	1898	571,684
1892	320,000	1899	652,478
1893	360,000		

There were no new lines of transportation established last year, but several new boats were added to the old lines.

The following letters from Mr. Greatsinger, president and general manager of the Duluth and Iron Range Railroad Company, states the situation from the standpoint of the railroad company, giving facts relating to the growth of commerce at Agate Bay and the necessity of adding Burlington Bay to their harbor space.

DULUTH, MINN., *August 1, 1900.*

MY DEAR SIR: I beg to call your attention and submit the following facts expressing the urgent need of immediate improvements to Burlington Bay by the Government:

The reports show the immense amount of business that we are doing in Agate Bay, and its rapid increase in volume. We now have five ore docks, a coal and a merchandise dock in Agate Bay, and in order to handle our increased business in sight we are obliged to have more harbor room for ore, coal, and lumber docks. The coal receipts increase in proportion to the ore mined, while the lumber shipments increase in a greater proportion than the ore shipped.

There is tributary to this harbor over 2,000,000,000 feet of lumber, the greater portion of which will have to be shipped from Two Harbors. In 1888 the lumber shipments were 6,000 tons, while in 1899 they were 81,000 tons, and this only represents a partial development. The iron-ore shipments in 1888 were 569,000 tons, while in 1899 the shipments reached the sum of 4,465,000 tons.

All of the available space for docks in Agate Bay is at present occupied, and it is not advisable or practicable to build any more, or extend those already there, on account of the large volume of business, danger from fire to the docks, and the increased size of vessels that are now trading at this harbor. The limits of this harbor have been fixed by the construction of the Government breakwater, and it is impossible to enlarge it.

There are times when there would be no opportunity for this harbor to be used as a refuge in case of storms, unless all of the boats in the harbor were located between the docks. It is not an uncommon thing during the shipping season for 15 or more large-sized vessels to be in the harbor at one time. It has, therefore, become necessary, in order to meet the demands of commerce and this railroad, and of vessels entering this port, that we secure increased harbor facilities and commence at once the erection of an ore dock of greater height and capacity than any we now have and additional coal and lumber docks in Burlington Bay. We have our lines run for the extension of our railroad to this bay and plans for the location and construction of said additional docks.

In order to protect the first new dock it will cost us $50,000 for the rock work in the cribs alone, and that will only furnish us a small amount of protection. The docks would be liable to be destroyed even with that expenditure, as the danger is from the northeast winds, which are the prevailing ones. Therefore, if the east breakwater can be constructed within the next year we can handle a large amount of business from this bay next season, but the west breakwater should also be put in as soon as practicable.

After this bay has been properly protected by breakwaters, it is then available for the location and erection of grain elevators, thereby shortening the distance between the grain fields and the eastern consumer.

We also have a large and growing industry tributary to Two Harbors in the shipping of pulp wood, which will require large dock facilities, our shipments of which this year have already amounted to 10,000 cords.

With this bay protected, it will admit of the storing of saw logs and the erection of sawmills. The present facilities do not afford or admit of large package freighters trading at this harbor, while with Burlington Bay improved it would afford them ample facilities. When the present breakwater and harbor were located, 250 feet was an ordinary length of vessel, while at the present time 500 feet is not an unusual length.

Very respectfully submitted.

J. L. Greatsinger,
President and General Manager.

Maj. Clinton B. Sears,
Corps of Engineers, U. S. A., Duluth, Minn.

Duluth, Minn., *August 4, 1900.*

Dear Sir: I omitted to state in my letter to you of the 1st instant that the estimated cost of the first ore dock into Burlington Bay, including the railroad tracks, that we ought to build this year to meet our increased demands is $600,000, and the lumber docks and dock for handling spruce pulp wood I estimated at $150,000, with suitable tracks.

Very truly, yours,

J. L. Greatsinger,
President and General Manager.

Maj. Clinton B. Sears,
Corps of Engineers, U. S. A., Duluth, Minn.

To the foregoing letters of Mr. Greatsinger may be added the following data from other sources relative to the prospective commerce of Burlington Bay:

Mr. R. Angst, chief engineer of the Duluth and Iron Range Railway, informs me that there are 300,000,000 tons of iron ore naturally tributary to Agate and Burlington bays for shipment. This he considers a conservative estimate, and is liable to run higher. The present value of iron ore, at Two Harbors, he states to be about $3 per ton, and on this basis the value of future shipments of iron ore from Agate Bay and Burlington Bay will amount to the large sum of $900,000,000.

As to how much of this ore will be shipped from Burlington Bay, in case the latter be improved, it can not be predicted with any certainty, as it will depend largely upon the increase in the demand for iron. Taking into account (1) the growth of ore shipments from Agate Bay during the fifteen years' history of that port, (2) the growth of the country at large in population, (3) the per capita increase in the consumption of iron for structural and other purposes, and (4) the fact that the limits of the shipping capacity of Agate Bay have now been reached, Mr. Angst says he would not be surprised if in ten years from now as much additional ore would be shipped from Burlington Bay annually as now from Agate Bay; also that in the long run the amount shipped from Burlington Bay would be from one-half to two-thirds of the total from the two bays. The shipping plant at the two bays will be operated as a unit.

Outline plans for a complete system of ore docks for Burlington Bay, and for two lumber docks, have been furnished this office by Mr. W. A. McGonagle, resident engineer, Duluth and Iron Range Railway Company, as per inclosed blue-print map,[1] scale 300 feet to 1 inch, dated August, 1900. Mr. McGonagle states that the cost of building the five proposed ore docks will be about $3,000,000. Mr. Greatsinger tells me it is planned to spend $600,000 on these ore docks the first year, the same sum the following year, and one-half that sum the third year, making $1,500,000 in three years.

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[1] Not printed.

The prospective commerce is of such magnitude and so well assured by the foregoing statement and the thoroughly reliable character of the railroad company as, in my opinion, to justify the improvement of Burlington Bay by the Government.

The cost of improvement would be considerable on account of the deep and wide entrance, probably as much as $400,000 if the usual type of breakwater on the lakes be adopted, but this sum is only 13 per cent of what the railroad company expects to expend on ore docks alone, and but one-thousandth part of the value of the freight that is likely to be handled there.

HARBOR OF REFUGE.

The improvement of Burlington Bay would also add to the harbor of refuge facilities of the north shore of Lake Superior, which is a matter of importance on account of the growth in the coastwise trade. A sawmill has been built this year at Little Marais, a logging road is under construction at Split Rock, with a large dam and other improvements, at Gooseberry River a dam is being built for logging operations, logging camps are located elsewhere, and a large business in getting out railroad ties has sprung up, distributed at various points along the shore. Rock quarries and gravel deposits are being developed and utilized. The enterprises mentioned lie between Agate Bay and Grand Marais, Minn., and are all without any or but slight protection from storms, so that tugs, lighters, etc., engaged in business along there have to run for shelter in time of a severe storm. The prevailing storms are from the northeast, and in such storms Agate Bay or Burlington Bay would be the most available shelter. There have been quite a number of wrecks and accidents to vessels along this stretch of coast in recent years, and Agate Bay is the nearest point where assistance can be obtained.

There being no harbor of refuge on the south shore of the lake, between Duluth and the Apostle Islands, Agate or Burlington Bay would also be the nearest point of shelter for vessels bound down the lake when midway between those two points.

Without the improvement of Burlington Bay, Agate Bay would probably be often too crowded with vessels doing business there to accommodate those seeking shelter.

COST OF SURVEY.

In case of a survey and project for improvement, with estimated cost of same, be ordered, the following data, now at hand, will be of use:

1. Lake Survey Detail Chart, 1868.
2. Report of Maj. Chas. J. Allen, Corps of Engineers, U. S. A., of the results of a survey of Agate and Burlington bays, dated January 5, 1885, accompanied by a map, 300 feet to 1 inch, from surveys by Randell Hunt, assistant engineer, in December, 1884.
3. Map of Burlington Bay, by the Duluth and Iron Range Railway Company, dated April, 1900, scale 100 feet to 1 inch, with soundings 50 feet apart in each direction, taken through the ice in last winter or early spring, and covering the greater part of the bay.
4. Map of Agate Bay and Burlington Bay, by the Duluth and Iron Range Railway Company, 300 feet to 1 inch, based on the Randell Hunt map of 1884, showing present and proposed improvements by the railroad company.

The foregoing maps will render a complete new survey unnecessary. Some additional soundings will be needed, also an examination of the bottom by means of an iron rod, to test its firmness for sustaining an embankment. This field work, and office work on plans and estimates, will cost not to exceed $600, and can probably be done for $400.

Respectfully submitted.

J. H. Darling,
Assistant Engineer.

SURVEY OF BURLINGTON BAY, LAKE COUNTY, MINN., WITH A VIEW TO IMPROVING SAID BAY AND CONSTRUCTING A HARBOR THEREIN.

United States Engineer Office,
Duluth, Minn., November 10, 1900.

General: In compliance with your letter of September 6, 1900, I have the honor to submit the following report on the survey of Burlington Bay, Minnesota.

This report is accompanied by the subreports of Mr. J. H. Darling, assistant engineer, and Mr. M. W. Lewis, draftsman, under grade of junior engineer, and by a tracing[1] and blue print therefrom.

To these reports and the maps attention is invited for details of survey and for analysis of project for improvement.

The report on the preliminary examination of this bay was submitted August 13, 1900, and contained the following paragraphs:

* * * * * * *

Burlington Bay is one of the two bays situated at the town of Two Harbors, Minn., the other being Agate Bay, and these two bays give the town its name. Agate Bay has already been improved by the Government, the project for its improvement to be completed in 1901. It is limited in size and its capacity is now being fully utilized by the Duluth and Iron Range Railroad Company, making the improvement of Burlington Bay a necessity to meet the growing commercial demands of the port of Two Harbors. Due to the undoubted rapid growth of this commerce in the near future, and to the necessity for further harbor refuge, I deem Burlington Bay worthy of improvement by the Government.

* * * * * * *

Burlington Bay has no commerce. Its shores are unimproved and practically unoccupied. The entire shore line and adjoining land to a greater or less distance back is owned by the Duluth and Iron Range Railroad Company, incorporated under the laws of the State of Minnesota, which company also owns the Agate Bay shore line and abutting land. The principal business of this road is the carrying of iron ore, but it does a general freight and passenger business as a common carrier.

* * * * * * *

This bay, however, is an essential part of the port of Two Harbors, and, in studying the amount of improvement to be made, the whole commerce of the port, past and prospective, should be carefully considered.

The total cargo tonnage into and out of this port for fourteen years ending December 31, 1899, is estimated at $40,000,000. It increased from 236,000 tons, valued at $524,000, in 1885, to 4,604,252 tons, valued at $9,500,000, in 1899. The total amount appropriated for the improvement of this port to June 30, 1900, has been $244,208, or sixty-one one-hundredths of 1 per cent of the commerce for the past fourteen years, and only 2½ per cent of the commerce of this port for 1899.

Assistant Engineer Darling recommends the construction of a breakwater for the improvement of Burlington Bay of the type usual for the Lake Superior harbors, viz, a timber crib and superstructure on a riprap embankment, and he presents two alternative positions and lengths—one shown at A, 2,700 feet long, and estimated to cost $435,000, and one shown at B, 2,200 feet long, and estimated to cost $376,500. A continuous contract appropriation would reduce these figures about 10 per cent.

The exact length and location of the breakwater may well be left for future consideration, but it is certain an effective improvement can be made for $435,000, and perhaps for much less. This is only nine-tenths of 1 per cent of the commerce of this port for fifteen years ending November 1, 1900, and, added to the $244,208 already appropriated for the other half of the port, makes $679,208, or 1.4 per cent of said commerce, to say nothing of the large annual commerce of the many coming years during which no further expenditure will be justified or required.

By the letter of Mr. Greatsinger, president and general manager of the Duluth and Iron Range Railroad, appended to my preliminary report, it will be seen that the company proposes to begin very soon, in Burlington Bay, the erection of ore docks and lumber docks to meet its rapidly increasing business. It has been claimed by some that the improvement of this bay should not be undertaken by the Government, since the property protected all belongs to one corporation. If this be correct, then the $244,208 already appropriated for Agate Bay was wrong, as the property protected there all belonged to one corporation. In my opinion the amount of commerce to be benefited is what should determine the worthiness of the appropriation and not the ownership of that commerce, be it in the hands of one or many. In this case, however, though the riparian ownership rests in one party, the general commerce to be benefited lies with many owners, for thousands of tons of cargo are brought into and taken from this port in vessels not owned by this one corporation.

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[1] Not reprinted; printed in House Doc. No. 114, Fifty-sixth Congress, second session.

In my opinion, therefore, based upon the absolute commerce of this port in the past, and its undoubted rapid increase in the near future, that part of it known as Burlington Bay is worthy of improvement to the amount of from $435,000 to $450,000, the commerce to be benefitted having at present an annual value of $9,500,000.

The improvement recommended is the erection of a breakwater running out from the eastern point of the bay, in a general southwestern direction, and estimated to cost not to exceed $435,000, which amount may be reduced ten per cent by an appropriation authorizing a continuous contract.

Very respectfully,

CLINTON B. SEARS,
Major, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[Third indorsement.]

U. S. ENGINEER OFFICE, NORTHWEST DIVISION,
New York, November 26, 1900.

Respectfully returned to the Chief of Engineers.

The value and importance of this improvement is undoubted, but since it would appear that the pecuniary benefits resulting therefrom will accrue to a single corporation, it is questionable whether this work should be considered of such national importance as to warrant its being undertaken by the United States Government.

J. W. BARLOW,
Colonel, Corps of Engineers,
Division Engineer.

REPORT OF MR. J. H. DARLING, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Duluth, Minn., November 8, 1900.

MAJOR: I have the honor to report that, in accordance with your instructions, a survey of Burlington Bay has been executed, and a project for its improvement suggested for your consideration, with estimates of cost, based upon the results of the survey.

Survey.—This was made by Mr. M. W. Lewis, draftsman, under my immediate direction, in the month of September last. A detailed report of this survey is given by Mr. Lewis, together with a map of the locality drawn by him, and reference to these is made herewith.

This survey was not a full one, but rather supplementary to previous surveys, which rendered a full one unnecessary. Of these previous surveys, the earliest is that of the United States lake survey of 1861, the unpublished detail chart of which was mapped to the scale of 1: 16,000. This is on a small scale and lacks detail needed for the present purpose. Some of the deep-water soundings are included in Mr. Lewis's map.

The next survey made was in 1884, by Mr. Randell Hunt, assistant engineer, under direction of Maj. C. J. Allen, and mapped to scale of 300 feet to 1 inch. This survey included Agate Bay also, and formed the basis for a project for the improvement of both Agate and Burlington bays, as reported by Major Allen to the Chief of Engineers, under date of January 5, 1885 (House Ex. Doc. No. 94, Forty-eighth Congress, second session), and to which further reference will be made.

Further surveys were made by the Duluth and Iron Range Railroad Company during the past year, as a preliminary to the formation of plans for the construction of ore docks and other wharves in Burlington Bay, and of track approaches. Blueprint copies of their maps have been received by this office. They are on a large scale, 100 feet to the inch, and include numerous soundings of depths of water covering the greater portion of the bay; were mostly taken early last spring through the ice, spaced by chaining off parallel lines on the ice so as to make the soundings 50 feet apart each way. These soundings we have checked by comparison with those of the Hunt survey, and with the more recent ones by Mr. Lewis, showing fair agreement and probable correctness. The method of taking them was such as to give accurate results, and they were reduced to 100 feet above the railroad datum, which nearly coincides with our low-water datum.[1] These soundings have been embodied in the present map, also spirit-level contours which were run out by the railroad company for use in their track approach plans.

The railroad company has also furnished this office with a blue print showing their plans for a system of ore docks, five in number, and two lumber docks, the outlines of which are traced on map herewith, in broken lines. The ore docks, it is understood, have been planned to best accommodate the company's large business which it expects to transact at this harbor, and have been specially arranged with reference to the conformation of the ground over which the track approaches are to be laid, and the necessity of a high elevation for the docks. These ore docks will occupy a large part of the harbor area, and of course should be expected to do so in view of the quantity of ore that is to be handled by them. The plans have been worked up with care, and in my opinion will not interfere unnecessarily with the general interests of navigation, or with any rational plan for the improvement of the harbor. There is room for other wharves than those outlined, along the north shore of the harbor.

In Mr. Lewis's survey soundings were taken up where the railroad company left off, and extended into deeper water to a depth of 100 feet, and so as to cover all possible positions for breakwater construction, and tests were made of the character of bottom over the same locality, indicating sufficient firmness for founding a breakwater embankment out to a depth of about 65 feet. Gauge readings were taken for reducing soundings, and were extended over a period of one and one-half months for the purpose of determining elevation of gauge zero by means of comparison with another United States gauge at Houghton, Mich., this being rendered necessary by the destruction of our former bench marks at Agate Bay. By this means and by spirit levels another permanent bench mark was established and a determination made of the elevation of the railroad datum with reference to low-water datum.

Projects for improvement.—Any project for improvement would necessarily include a breakwater. It might also include dredging inshore along the north side of the bay, so as to enlarge the navigable area, which is none too large at best; but as the development of the harbor for commercial purposes, aside from the iron-ore business, will require the building of wharves out into the bay to about the present navigable depth, and the ore docks will extend out still farther, the only dredging likely to be needed is that of excavating slips alongside the wharves and ore docks, and this should be done by the owners of the frontage, and not by the United States.

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[1] One hundred feet above Duluth and Iron Range Railroad datum = 0.18 foot above low-water datum.

Breakwater.—The bay is now partially protected from storms by the points of land on either side, forming to some extent a natural harbor, yet is so much open to the lake as to require an artificial breakwater before vessels can lie in safety in any and all storms to which the locality is subject. The bay is situated much the same as Agate Bay in this respect, but is more sheltered from southwest storms than the latter on account of the relatively greater length of the westerly point of land. The worst apparent exposure is from the south, southeast, and east directions, but weather records and experience have established the fact that no severe storms occur from those quarters. On this point, Mr. Randell Hunt reported as follows:

* * * * * * *

"Burlington Bay is almost wholly sheltered from southwest storms by the rocky point which separates it from Agate Bay. It is thoroughly opened and exposed to southeast storms, and to considerable extent to those from the northeast.

* * * * * * *

"Mr. E. R. Brace, of the United States signal office at Duluth, has furnished me with a table showing the prevailing winds at that point for several years back. These results may be applied to the locality of Agate and Burlington bays without any danger of being much out of the way, probably making a small allowance for the increased velocity of those winds which come from the southern quarters, due to the stretch of the lake.

"From this table it appears at a glance that the southwest and northeast storms are the prevailing ones. In addition to this Mr. Brace has informed me by letter—

" 'That we consider a dangerous wind from any direction to be one of 25 miles or over. I have carefully examined my records from 1875 to date, and can not find a single instance where a southeast wind has reached that velocity. We occasionally have southeast winds, but it is not a quarter from which we expect storms.'

"Lake captains and others interested are all agreed that Agate Bay needs most protection from southwest winds; that southeast storms are rare; and that the waves of a continuous northeast storm cause more or less 'dead swell' throughout the bay.

* * * * * * *

"The following is a copy of the prevailing wind directions as taken from the official records at the United States signal station, Duluth, Minn.:

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1873	NE.	NE.	NE.	NE.	NE.	NE.	NE.	NE.	NW.	SW.	SW.	SW.
1874	SW.	SW.	NW.	NE.	NE.	NE.	NE.	NE.	SW.	NE.	SW.	SW.
1875	SW.	SW.	NE.	NE.	NE.	NE.	NE.	NE.	NE.	NE.	SW.	NW.
1876	SW.	NE.	NE.	NE.	NE.	NE.	NE.	NE.	NE.	SW.	SW.	NW.
1877	W.	SW.	NE.	NE.	NE.	NE.	NE.	NE.	E.	SE.	NW.	NE.
1878	SW.	NE.	NE.	NE.	NE.	NE.	NE.	NW.	NE.	W.	SW.	SW.
1879	SW.	NW.	SW.	NE.	NE.	NE.	NE.	NE.	NW.	NE.	NW.	SW.
1880	SW.	NE.	NE.	NE.	NE.	NE.	NE.	NE.	SW.	NW.	SW.	SW.
1881	SW.	NE.	NE.	NE.	NE.	NE.	NE.	NE.	NE.	NE.	SW.	SW.
1882	SW.	NE.	NE.	NE.	NE.	NE.	NE.	NE.	NE.	NE.	W.	W.
1883	W.	W.	NW.	NE.	NE.	NE.	NE.	NE.	W.	NE.	W. SW.	SW.
Average for 11 years.	SW.	NE.	NE.	NE.	NE.	NE.	NE.	NE.	NE.	NE.	SW.	SW.

Individual observations since then, by the writer and others, confirm the above statement.

Northeast storms affect the bay most, sending in heavy swells, and southwest storms in a less degree.

Major Allen's project for the improvement of Burlington Bay, as stated in his report of January 5, 1885, comprised a breakwater on the west side of the bay, having the position shown by light dotted lines and designated D E F on map herewith, affording shelter to about 15 acres of harbor area, the estimated cost of which was $160,000, and dredging into the low ground behind the breakwater at a cost of $50,000. This project evidently did not contemplate the utilization of the entire bay for the purposes of a harbor, and now that the entire area seems to be required for commercial purposes and for a refuge, as fully set forth in your preliminary report of August 13, 1900, it is clear that the project quoted above would be entirely inadequate.

Two locations for a breakwater are suggested for your consideration, designated A and B on the accompanying map, one or the other of which it is believed would answer the requirements. Each starts from the east point, and passing from 2,200 to 2,700 feet across the front of the bay leaves an entrance for vessels on the west side at the deepest water, and from a direction most convenient for vessels in approaching the docks.

The heavy seas from northeast storms, which are the worst storms to provide against, as they sweep around the east point of land will be partially broken and partially deflected to the west by the breakwater and, together with some of the direct waves, will strike the rocky and broken shore on the west side of bay, resulting in the dissipation of most of their energy. That portion of the west shore from C to D may be expected to reflect some portion of these waves into the harbor. In case location A were constructed these reflected waves would undoubtedly be moderate, and would be further stilled by the basin before reaching the docks and wharves and would probably cause no inconvenience to shipping.

In case of location B,[1] which is a shorter breakwater, with a wider entrance to the harbor, the reflected waves from the west shore, together with the direct wash around the end of the breakwater, would, of course, cause more disturbance to the water inside the harbor, but possibly not beyond the point of toleration for vessels lying at the wharves.

From southwest storms the entrance with A would be well under the shelter of the westerly point of land, and probably subject to only a slight wash coming around the point. With B the exposure would be greater, but may be not dangerously so.

Each of these two locations extends the breakwater to a depth of 60 feet of water, which is near the limit of firm bottom, as found by the testing rod, and is also near the limit of prohibitory cost of construction, the cost per linear foot at this depth being about $260, as against $137 in a depth of 40 feet, and $54 in a depth of 20 feet, for the ordinary form of structure. The deep-water construction presents no special engineering difficulties.

While A from its greater length would give better protection, B would give more room in the harbor, which might be needed for anchorage by vessels seeking refuge, or for mooring to buoys, piles, or piers inside the space between the breakwater and the ore docks. The tendency to build larger and larger vessels in past years, and which still prevails, adds to the importance of making a small harbor as large as possible. It may be added that the larger vessels are less sensitive to roughness of water and therefore require less complete protection, but the smaller vessels we have always with us and must be considered. B would also cost less than A, as will be seen by the estimates herewith, mainly by reason of its shorter length, and also from its following the crest of a shoal for a few hundred feet from shore.

The entrance should be wide enough to avoid all danger of a vessel being thrown onto the rocky shore at the west side of the bay while entering during heavy northeast storms and while also the vessel would be running in the trough of the sea and less steady on that account. The width of entrance for location A is 1,300 feet, about one-fourth mile, and the water is deep for nearly the full width. This should be ample. In case of B there is a large excess over necessary width of entrance, it being 2,000 feet.

The harbor area protected by a breakwater in location A would be 167 acres, and by location B 185 acres. This includes the space bounded by the breakwater, and the shore line from the shore end of the breakwater around to a point on the west side due west of the west end of the breakwater.

Kind of breakwater.—The kind believed to be best suited to the conditions at Burlington Bay is of the general type constructed in recent years at most of the harbors of this district, consisting of timber cribs filled with stone and resting upon a stone embankment, and a continuous superstructure also of stone and timber. This superstructure will admit of being replaced some time in the future by the more durable and permanent concrete form, as has been done at some of the lower lake harbors, and of which the Marquette breakwater superstructure designed and built by you is a good example. Such a permanent superstructure should not be built until the cribs and embankment have had time to settle to a firm and unyielding position.

The cross section of the timber pier, including crib and superstructure, should be designed with reference to stability and economy. A square form seems to be about what is required to provide against overturning, though in shallow water it should be wider than the depth, in order to retain sufficient weight to prevent displacement by sliding laterally.

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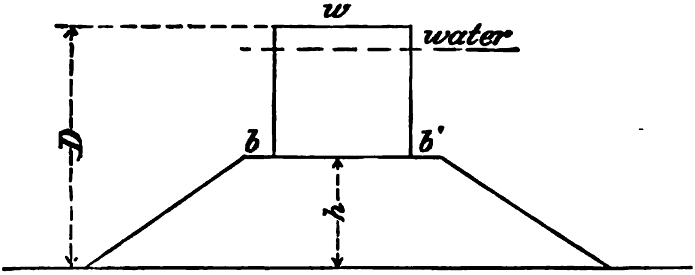
[1] This location was suggested by Mr. Lewis.

To determine the dimensions of the timber pier of square form of cross section and height of stone embankment in varying depths of water for least cost of breakwater, we may proceed as follows. Let



D = depth of breakwater.
h = height of embankment.
w = width and depth of timber pier.
b'' = sum of berms b and b'.
s = ratio of slope base to vertical.
r = ratio of cost of timber pier to embankment for equal volumes.
u = cost of linear foot of breakwater in terms of a cubic foot of embankment.

Then

$$u = r\,w^2 + h\,(w + b'' + sh) \quad . \; . \; . \; . \; . \; . \qquad (1)$$

and as $h = D - w$

$$u = r\,w^2 + (D - w)\;(w + b'' + sD - s\,w).$$

For minimum value of u,

$$\frac{du}{dw} = 2\;(r + s - 1)\;w + D - sD - b'' - sD = 0.$$

and

$$w = \frac{b'' + (2s - 1)\;D}{2\;(r + s - 1)} \quad . \; . \; . \; . \; . \; . \; . \qquad (2)$$

which gives the width and depth of the timber pier in terms of the total depth of the breakwater and several constant terms, for minimum cost of entire breakwater section.

This formula was first deduced by the writer in 1886, in connection with a project for a breakwater at Agate Bay.

For determining the cost of a timber pier filled with stone, per unit of volume, and the ratio, r, of this cost to that of the stone embankment, the quantities of material in the recent extension of the west breakwater at Agate Bay may be taken as sufficiently correct for this purpose, although that form of structure might be modified advantageously in some details for use on the Burlington Bay work for the sake of greater stability, greater strength of the framed structure, and of economy of timber, without materially altering the cost.

On the Agate Bay extension referred to, the cross section of the timber pier is 24 by 24½ feet for cribs and superstructure together. The following estimate is for 50 linear feet, containing 29,400 cubic feet in volume. Prices are intended to represent the probable cost for material in place, together with 15 per cent for contractor's profit and 5 per cent for contractor's risk.

Pine timber, 76,720 feet B. M., at $25	$1,918.00
Iron fastenings, 5,257 pounds, at 3 cents	158.00
Stone ballast, 162 cords (128 cubic feet), at $6	972.00
Cost of 50 linear feet, or 29,400 cubic feet	3,048.00
Cost per cubic foot of timber pier	.104
Cost per cubic foot stone ballast or embankment	.047

Ratio of former to latter, $r = 2.2$.

The following table is computed from formula (2) for several depths of water, and supposing the superstructure to rise 6 feet above water, and taking $r=2.2$, $s=3/2$, or 1½ to 1, for embankment slopes, and $b''=15$ feet for the sum of widths of the two berms.

Depth of water.	D=Depth of entire breakwater.	W=Economic width of timber pier.
Feet.	*Feet.*	*Feet.*
10	16	8.7
20	26	12.4
30	36	16.1
40	46	19.8
50	56	23.5
60	66	27.2
70	76	30.9

In shoal water this rule gives too small dimensions for stability, as may be seen at a glance. When the east breakwater at Agate Bay, which is quite similarly situated to the one proposed for Burlington Bay, was built to a distance of 500 feet from shore, and stopped while further appropriations were awaited, the outer end of the timber pier suffered a movement of about 2 feet laterally toward the harbor. The time and cause of this is not definitely known, but was probably due to either storms or ice pressure. At this point the timber was 20 feet square in section, and the depth of water 25 feet. With this exception, this breakwater has held its position well. The last of the completed portion was built in 1891, stopping in 38 feet of water, with a timber pier cross section of 24 by 24½ feet. The inner end was started in 10 feet of water, with a 16 by 16 foot timber pier. There is now under construction an extension to the Agate Bay east breakwater, which terminates in 56 feet of water, and is 24 feet wide, excepting the last 50 linear feet, which is 30 feet wide.

In the light of what precedes it seems best to have no width less than 24 feet. For the deeper water, the economic dimensions may be safely taken; that is, 28 feet to the nearest even foot, with an increase in width at the end, which is the weakest point, forming a pierhead.

Profiles and cross sections are drawn on the accompanying map in accordance with the foregoing.

Credit is due to Mr. Lewis for the execution of these drawings and for assistance in preparation of estimates.

The cost of breakwater at location A, at prices already named, and with 10 per cent added for administration, would be about $434,975; at location B, about $376,490. This supposes that the breakwater be built a portion at a time, and under successive contracts, as has usually been the method in former years. In case Congress appropriates a sum sufficient to complete the work at once, or provides for a continuous contract, the cost would be less by probably 10 per cent, making the cost for A $391,439, and for B $338,841.

There is a large body of rock near the site, or within half a mile, on high ground, that might be run by gravity down to the bay. This rock is hard, but breaks up too small for large riprap. It might make good crib filling, and answer for the core of the embankment, and for the entire width of the base in deep water below the level of violent wave action.

For the upper slopes of the embankment large pieces of granite should be used, of which there is an excellent quarry at Silver Creek, 4 miles from Burlington Bay, weighing 180 pounds to the cubic foot, and another quarry 7 miles away and 1 mile east of Knife River, with rock weighing 170 pounds to the foot.

Commerce.—At present there is no commerce at Burlington Bay. The prospective commerce is shown as fully as possible to ascertain in the report upon a preliminary examination dated August 13, 1900. The utility of this bay as a harbor of refuge is also stated in that report, and reasons for believing the harbor worthy of improvement by the United States.

Figures for the shipments of ore the present season up to November 1 are at hand, the amount being 3,762,193 tons. This is 236,011 tons in excess of the amount shipped last season up to November 1, and last season's shipments were much greater than those of any former year.

As stated in report on preliminary examination, the Duluth and Iron Range Railway Company owns the adjacent land at Burlington Bay as well as at Agate Bay, and of course this road is alone in the business of handling ore at that locality. For the reason of lack of diversity of interests, it has been claimed that the harbor of

Burlington Bay is not worthy of improvement by the Government. The business of the railroad is very large, and requires most of the available room for docks and tracks, at both harbors, and so has the appearance of a monopoly. Its business, however, is a strictly legitimate one and in accordance with the laws of this State, as I believe. The corporation is not a trust in either the legal or popular sense of the term. There is hardly room or occasion for another road to have a terminus at that locality with a system of docks.

This large business in handling ore from the ranges for several iron companies, of which the Minnesota Iron Company is only one, and in loading the ore on vessels for shipment East, is an equally great public utility as if subdivided among a number of individuals or smaller companies, and probably more so, as the nature of the business is such that it can not be successfully conducted on a small scale. However, it would seem as if the magnitude of this business in the aggregate, present and prospective, and not its diversity, should be considered in deciding the question of the worthiness of improvement of the harbor by the Government.

The Duluth and Iron Range Railway has competitors, in fact, in hauling ore from the Mesaba Range, namely: The Duluth, Missabe and Northern Railway, which hauls a large amount to its docks at Duluth, and the Eastern Minnesota Railway, which hauls ore from other mines on same range to ore docks at Allouez Bay. So that the ore handled by the Duluth and Iron Range Railway Company is only a subdivision of the entire iron-ore business at the head of Lake Superior.

Very respectfully submitted.

J. H. Darling,
Assistant Engineer.

Maj. Clinton B. Sears,
Corps of Engineers, U. S. A.

REPORT OF MR. MARCUS W. LEWIS.

United States Engineer Office,
Duluth, Minn., November 8, 1900.

Major: I herewith submit a report of work done at Burlington Bay, Minnesota, in connection with a survey of same under the immediate direction of Mr. J. H. Darling, assistant engineer.

Arrived at Two Harbors September 12, 1900, and on the morning of the 13th I procured a party of four men and began the cutting out of range lines on the north and west shores of the bay for the purpose of locating soundings. The territory was generally well wooded, and much cutting was necessary. Sixteen lines were opened up and white-cloth targets placed on each. A considerable portion of the bay had previously been sounded by a party of the Duluth and Iron Range Railroad Company, and my soundings were confined to territory lying outside of this.

The soundings were made from a rowboat every minute, on lines east and west, 200 feet apart, and when a north and south range line was passed, the exact time was noted. These north and south ranges varied from 200 to 500 feet apart.

Readings were taken on a water gauge, during the progress of sounding, for the purpose of reducing the same to low-water datum. Owing to the destruction of all former bench marks which located the plane of low-water datum, it was found necessary to obtain a series of gauge readings which could be used in relation with those taken elsewhere of known elevation, and for this purpose readings were taken three times a day on a United States water gauge located at the east end of the east breakwater at Agate Bay, beginning September 13, 1900, and continuing until November 1, 1900.

These readings were taken at 9 a. m. and at 1 and 5 p. m., except when the water was too rough.

Readings are also taken at 7 a. m. and 6 p. m. at Houghton, Mich., on a gauge of known elevation. The readings at Houghton, Mich., are preferred to those at Duluth, Minn., from the fact that those of the latter place are at times influenced by the stage of water in St. Louis River. At time of this survey there was a small difference in stage of water in Duluth Harbor and the lake. After eliminating all readings taken when wind was fresh, or stronger than fresh, at either place, a mean of forty-nine readings was used at each station, which shows that the zero of the two harbors, or Agate Bay water gauge, is 0.11 feet below low-water datum. Allowance is made for this in the reduction of soundings.

Levels were taken fixing the relative heights of the water gauge used at Agate Bay, and a permanent bench mark consisting of a cross on a large granite bowlder, situated about 140 feet east of east end of east breakwater, and on line with south face of same. This cross is the station that was used by the Government in locating the position of the breakwater in 1884, and its elevation referred to low-water datum is +12.56 feet.

The Duluth and Iron Range Railroad Company have used this bench mark and referred it to their datum, which they use in all their surveys. The elevation of this bench mark referred to the railroad company's datum is 112.38 feet, as given me by their assistant engineer, George Watts.

From this it is seen that the 100 plane of the railroad company is 0.18 feet above low-water datum.

An examination was made for the purpose of ascertaining the character of the bottom of Burlington Bay, in the following manner: A steel rod three-fourths inch in diameter, and 8 feet long, pointed, was lowered from the boat by means of a line, and by raising and lowering it suddenly the condition of the bottom could be obtained with a considerable degree of accuracy.

It was found that from the shore line to a depth of about 25 feet the bottom consisted of gravelly clay, bowlders, and ledge rock, varying slightly in different localities. From the above depth to the depth of 60 or 65 feet firm clay was found. In depths greater than this the bottom was mud, into which the rod would penetrate probably 12 to 18 inches, making it a difficult matter to raise again.

Work was completed on the evening of September 20, 1900, and I returned to Duluth by steamer *Dixon* September 21.

Very respectfully submitted.

MARCUS W. LEWIS,
In charge.

Maj. CLINTON B. SEARS,
Corps of Engineers, U. S. A.

APPENDIX L L.

IMPROVEMENT OF RIVERS AND HARBORS ON WESTERN SHORE OF LAKE MICHIGAN.

REPORT OF MAJOR J. G. WARREN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1901, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Menominee Harbor, Michigan and Wisconsin.
2. Menominee River, Michigan and Wisconsin.
3. Oconto Harbor, Wisconsin.
4. Green Bay Harbor, Wisconsin.
5. Sturgeon Bay and Lake Michigan Ship Canal, Wisconsin.
6. Operating and care of Sturgeon Bay and Lake Michigan Ship Canal, Wisconsin.
7. Harbor of refuge at entrance of Sturgeon Bay and Lake Michigan Ship Canal, Wisconsin.
8. Ahnapee Harbor, Wisconsin.
9. Kewaunee Harbor, Wisconsin.
10. Two Rivers Harbor, Wisconsin.
11. Manitowoc Harbor, Wisconsin.
12. Sheboygan Harbor, Wisconsin.
13. Port Washington Harbor, Wisconsin.
14. Harbor of refuge at Milwaukee, Wisconsin.
15. Milwaukee Harbor, Wisconsin.
16. South Milwaukee Harbor, Wisconsin.
17. Racine Harbor, Wisconsin.
18. Kenosha Harbor, Wisconsin.
19. Waukegan Harbor, Illinois.
20. Fox River, Wisconsin.
21. Operating and care of locks and dams on Fox River, Wisconsin.
22. Removing sunken vessels or craft obstructing or endangering navigation.

EXAMINATIONS AND SURVEY.

23. Sturgeon Bay and Lake Michigan Ship Canal, Wisconsin.
24. Manitowoc Harbor, Wisconsin.
25. Milwaukee Harbor, Wisconsin.

United States Engineer Office,
Milwaukee, Wis., July 12, 1901.

General: I have the honor to transmit herewith annual report for the works of river and harbor improvement in my charge for the fiscal year ending June 30, 1901.

Very respectfully, your obedient servant,

J. G. Warren,
Major, Corps of Engineers.

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. A.

L L 1.

IMPROVEMENT OF MENOMINEE HARBOR, MICHIGAN AND WISCONSIN.

The original condition at the mouth of the Menominee River, object of the improvement, projects, and present works are described in detail in the Annual Report of the Chief of Engineers for 1896, pages 2459 and 2460.

Since then the channel has been increased in depth to 20 feet, with minimum width of 300 feet, in accordance with plan submitted November 30, 1896, and published in House Doc. No. 86, Fifty-fourth Congress, second session. This enlargement was fully completed in October, 1900.

Condition of the improvement.—The piers are built the full length contemplated. The superstructure of 2,318 linear feet of the inshore ends of the piers was recently rebuilt and is in good condition. The remainder of the superstructure, 1,050 linear feet, was built in 1884; it is much decayed and requires renewal.

The channel has a depth of 20 feet below datum, and a minimum width of 300 feet. The maximum draft that could be carried June 30, 1901, was 19.2 feet.

Operations during the fiscal year.—By hire of labor and the use of U. S. dredge No. 2 work was begun October 4, and completed October 31, 1900, resulting in the removal of 11,734 cubic yards of material, and the completion of the 20-foot channel to the required dimensions.

Remarks.—The chief benefit derived from expenditures made during the fiscal year was the elimination of one of the angles from the channel, thereby rendering navigation less difficult.

A consolidation of Menominee River and Menominee Harbor is recommended for reasons set forth in the Annual Report of the Chief of Engineers for 1900, page 3653.

It is proposed to expend the small balances available from appropriations for the improvement of Menominee Harbor and Menominee River in removing the most troublesome shoals in Menominee River, by hire of labor and the use of U. S. dredge No. 2 during the present working season.

For the maintenance of existing works an appropriation of $13,750 is recommended for the fiscal year ending June 30, 1903.

Estimate.

For rebuilding 1,050 linear feet of piers above the water line, at $10 per foot.	$10,500
For dredging 20,000 cubic yards for maintenance of channel, at 10 cents per yard	2,000
For contingencies, 10 per cent	1,250
Total	13,750

Money statement.

July 1, 1900, balance unexpended	$3,155.73
June 30, 1901, amount expended during fiscal year	1,275.05
July 1, 1901, balance unexpended	1,880.68
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement, in addition to the balance unexpended July 1, 1901	13,750.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

APPROPRIATIONS.

Act of—		Act of—	
March 3, 1871	$25,000	July 5, 1884	$10,000
June 10, 1872	25,000	August 5, 1886	3,000
March 3, 1873	25,000	August 11, 1888	9,000
June 23, 1874	25,000	August 18, 1894	10,000
March 3, 1875	25,000	June 3, 1896	7,150
August 14, 1876	8,000	March 3, 1899	5,500
June 18, 1878	10,000	Miscellaneous receipts credited to appropriations	62
March 3, 1879	10,000		
June 14, 1880	10,000	Total	234,712
March 3, 1881	12,000		
August 3, 1882	15,000		

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1900.

[Furnished by Mr. Nels Christophersen, deputy collector of customs, Menominee, Mich.]

Name of harbor, Menominee, Mich.; collection district, Marquette, Mich.; nearest light-house, Menominee, Mich.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	740	352,440	740	352,440

Exports and imports.

By way of the harbor only.	Tons.	Approximate value.
Exports	553,579	$5,000,000
Imports	616,210.5	3,000,000

L L 2.

IMPROVEMENT OF MENOMINEE RIVER, MICHIGAN AND WISCONSIN.

The original condition of the Menominee River, the object of the improvement, and the projects for carrying it out are fully described in the Annual Report of the Chief of Engineers for 1896, page 2463, and 1899, pages 2728–2729.

Condition of the improvement.—See Annual Report of Chief of Engineers for 1900, page 3653 and map published in House Doc. No. 419, Fifty-sixth Congress, first session. But a small quantity of material was dredged during the fiscal year, and soundings have not been taken since January, 1900; the condition of the channel has not materially changed since then.

The actual navigable depth June 30, 1901, was 19.2 feet at the entrance and for a distance of 2,300 feet inside of the pier heads; thence to the upper end of the channel, about 16.2 feet.

Operations during the fiscal year.—By hire of labor and the use of

U. S. dredge *No. 2*, 4,756 cubic yards of material were removed from shoal places in the channel during the month of November, 1900.

Remarks.—The benefit derived from expenditures during the fiscal year was the removal of several small shoals from the channel.

The recommendation that Menominee River and Menominee Harbor be made one work is renewed for reasons stated in Annual Report of Chief of Engineers for 1900, page 3653.

Attention is invited to report submitted January 30, 1900, with map and estimate of cost for increasing the depth of channel to 18 feet, published in House Doc. No. 419, Forty-sixth Congress, first session.

For the restoration and maintenance of channel an appropriation of $6,600 is recommended for the fiscal year ending June 30, 1903.

Estimate.

For dredging 50,000 cubic yards, at 12 cents	$6,000
For contingencies, 10 per cent	600
Total	6,600

Money statement.

July 1, 1900, balance unexpended	$808.21
June 30, 1901, amount expended during fiscal year	722.33
July 1, 1901, balance unexpended	85.88
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement, in addition to the balance unexpended July 1, 1901	6,600.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

APPROPRIATIONS.

Act of—	
September 19, 1890	$54,000.00
July 13, 1892	20,500.00
August 18, 1894	6,000.00
June 3, 1896	15,000.00
March 3, 1899	18,920.00
Miscellaneous receipts credited to appropriations	80.03
Total	114,500.03

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1900.

The commercial statistics for the Menominee River are the same as for Menominee Harbor, Michigan.

L L 3.

IMPROVEMENT OF OCONTO HARBOR, WISCONSIN.

The original condition of the Oconto River, the object of this improvement, the projects for carrying it out, and present works, are described in detail in Annual Reports of Chief of Engineers for 1896, page 2465, and 1897, page 2653.

Condition of the improvement.—See Annual Report of the Chief of Engineers for 1900, page 3654. It is believed that no material change has taken place since then, other than ordinary annual deterioration.

The actual depth of water June 30, 1901, based on soundings taken in May, 1900, was 8.2 feet.

Operations during the fiscal year.—Not any.

Remarks.—An inspection of the piers was made in September, 1900, and it was then evident that the method of repairs made in 1899, described in Annual Report of the Chief of Engineers for 1900, page 3655, has proved effectual, and it is proposed to repair the remainder of the piers in a similar manner whenever funds for that purpose are provided. The expenditures during the fiscal year were chiefly for repairs to the dredging plant.

Estimate for maintenance of existing works for the fiscal year ending June 30, 1903.

For dredging 40,000 cubic yards, at 12 cents	$4,800
For repairs to piers	5,500
For contingencies, 10 per cent	1,030
Total	11,330

Money statement.

July 1, 1900, balance unexpended	$1,372.69
June 30, 1901, amount expended during fiscal year	422.74
July 1, 1901, balance unexpended	949.95
Amount (estimated) required for completion of existing project	22,610.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement, in addition to the balance unexpended July 1, 1901	11,330.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

APPROPRIATIONS.

Act of—		Act of—	
March 3, 1881	$10,000	July 13, 1892	$3,000
August 2, 1882	15,000	August 18, 1894	3,000
July 5, 1884	15,000	June 3, 1896	4,000
August 5, 1886	8,000	March 3, 1899	15,000
August 11, 1888	20,000	Total	93,000

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1900.

[Furnished by Mr. Jacob Spies, mayor.]

Name of harbor, Oconto, Wis.; collection district, Milwaukee, Wis.; nearest lighthouse, Sherwood Point, Wisconsin.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	200	10,000	200	10,000
Sail	175	10,000	175	10,000
Total	375	20,000	375	20,000

Exports and imports.

	Tons.	Approximate value.
By way of the harbor only:		
Exports	12,958	$800,200
Imports	61,819.5	1,176,282
By all ways of transportation:		
Exports	204,015.5	3,267,000
Imports	183,509	2,978,475

L L 4.

IMPROVEMENT OF GREEN BAY HARBOR, WISCONSIN.

Fox River, near its mouth, constitutes the harbor of Green Bay. Its original condition, object of improvement, projects, and present works are described in detail in Annual Report of the Chief of Engineers for 1896, pages 2469, 2470; 1897, pages 2657, 2658, and 1899, pages 2734, 2735.

Condition of the improvement.—The east and west revetments at Grassy Island were rebuilt above the water line in 1885 and 1887; they are now so much decayed that renewal is necessary. The 17-foot channel, 16,500 feet long, extending from the mouth of Fox River through Grassy Island and Sable Point Bar, was completed in 1897. Soundings taken in January and February, 1901, on lines 50 feet apart at intervals of 20 feet, showed the channel to have, with a few unimportant exceptions, the required depth of 17 feet below the datum plane of harbor improvements, and a minimum width of 180 feet. It is probable that no material change has occurred since then. The actual depth, June 30, 1901, is 16.2 feet.

Fox River below Depere.—Dredging for the formation of a channel 17 feet deep and 150 feet wide was completed in November, 1899. Soundings taken in February, 1901, showed a number of shoals, but none that materially interfered with navigation.

Operations during the fiscal year.—There were no operations other than taking soundings through the ice, covering 7 linear miles of channel, preparation of maps showing its present condition, and making repairs to the dredging plant.

Remarks.—The project now in force for obtaining a channel of navigable width 17 feet deep from the waters of Green Bay to the city of Green Bay was practically completed in 1897 and a channel of the same depth was obtained in Fox River below Depere in 1899. The two improved channels have a combined length of about 7 miles, and the banks are unprotected with revetments except for a distance of 700 feet at Grassy Island, therefore dredging will be required from time to time for their maintenance.

It is proposed to rebuild the east revetment at Grassy Island above the water line the present working season with the funds now available.

Attention is invited to a report dated December 12, 1899, on a survey made with a view of obtaining a channel 20 feet deep, published in House Doc. No. 232, Fifty-sixth Congress, first session, and in Chief of Engineers Report for 1900, pages 3750–3752.

The benefits derived from the expenditures made during the fiscal year were ascertaining the present condition of the channels and making needed repairs to the dredging plant.

An appropriation of $15,000 for the maintenance of existing works for the fiscal year ending June 30, 1903, is recommended.

Estimate.

Green Bay channel:	
Dredging 25,000 cubic yards, at 12 cents	$3,000
Rebuilding west revetment at Grassy Island, 620 linear feet, at $10	6,200
Fox River channel below Depere:	
Dredging 30,000 cubic yards, at 15 cents	4,500
Contingencies	1,300
Total	15,000

Money statement.

July 1, 1900, balance unexpended	$7,432.98
June 30, 1901, amount expended during fiscal year	892.17
July 1, 1901, balance unexpended	6,540.81
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement, in addition to the balance unexpended July 1, 1901	15,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

APPROPRIATIONS.

Act of—		Act of—	
June 23, 1866	$30,500.00	August 2, 1882	$20,000.00
March 2, 1867	45,000.00	July 5, 1884	10,000.00
July 25, 1868 (allotted)	17,500.00	August 5, 1886	7,000.00
April 10, 1869 (allotted)	44,550.00	August 11, 1888	10,000.00
July 11, 1870	17,500.00	September 19, 1890	10,000.00
March 3, 1871	17,500.00	July 13, 1892	25,000.00
March 3, 1873	20,000.00	August 18, 1894	25,000.00
June 23, 1874	10,000.00	June 3, 1896	25,000.00
March 3, 1875	10,000.00	July 19, 1897	5,000.00
August 14, 1876	8,000.00	March 3, 1899	28,600.00
June 18, 1878	5,000.00	Miscellaneous receipts credited to appropriations	52.50
March 3, 1879	4,000.00		
June 14, 1880	6,000.00		
March 3, 1881	5,000.00	Total	406,202.50

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1900.

[Furnished by Mr. M. J. McCormick.]

Name of harbor, Green Bay, Wis.; collection district, Milwaukee, Wis.; nearest light-house, Grassy Island, Wisconsin.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	381	170,982	377	151,006
Sail	146	41,727	152	43,032
Unknown	71	68,709	71	68,709
Total	598	281,418	600	262,747

Exports and imports.

By way of the harbor only.	Tons.	Approximate value.
Exports	169,812.5	$6,500,000
Imports	847,959.5	5,500,000

L L 5.

IMPROVEMENT OF STURGEON BAY AND LAKE MICHIGAN SHIP CANAL, WISCONSIN.

The original condition, object of the improvement, project, and present works are described in detail in Annual Report of the Chief of Engineers for 1896, pages 2471, 2472; and for 1897, page 2660.

Condition of the improvement.—For a distance of 6,849 feet, measuring from east or lake end, the canal banks are protected by revetments. The remaining 351 feet of the canal is unprovided with revetments.

The following are the various widths of the canal between revetments, measuring from lake end:

720 feet, 130 feet wide.
5,480 feet, 160 feet wide.
649 feet, 250 feet wide.

June 30, 1901, the governing depth in the canal was about 15.8 feet below datum, and the actual depth about 15 feet.

Operations during the fiscal year.—By hire of labor and the use of United States dredge No. 1, the dredging and work incident to the renewal of the south revetment on the rectified line was continued, resulting in the excavation of 95,604 cubic yards of material, and the removal of about 2,500 linear feet of the old revetment.

In September and October, 1900, a survey was made, and under date of November 24 a report with plans was submitted for obtaining a depth of 18 feet of water from Lake Michigan to Green Bay, at an estimated cost of $218,000.

Remarks.—The so-called "harbor of refuge" at the Lake Michigan end of the canal really forms a part of the canal, being its easterly entrance, and the harbor piers really constitute exterior works. As a harbor of refuge it is valueless, but as an entrance to the canal it becomes of equal importance to the canal itself. It is therefore recommended that the two works be consolidated, and that in the future appropriations made for the improvement of Sturgeon Bay and Lake Michigan Ship Canal shall include the harbor of refuge at the entrance thereof.

The benefit derived from expenditures made during the fiscal year is the widening of about 2,300 linear feet, equal to 32 per cent of its entire length, from 130 feet to 160 feet, in furtherance of the existing project.

Attention is invited to report and plans submitted under date of November 24, 1900, for obtaining a channel of navigable width, 18 feet deep, from Lake Michigan to Green Bay, published in House Doc. No. 117, Fifty-sixth Congress, second session.

Estimated cost of project adopted in 1894 (see Report of Chief of Engineers, 1894, p. 2057)		$98,450
Additional estimate, modified project of 1896:		
Increasing width of westerly 1,000 feet of canal to 250 feet	$4,750	
Increasing width of channel in Sturgeon Bay to 200 feet	10,300	
Total additional estimate		15,050
Total		113,500
Total appropriations, exclusive of purchase		80,000
Amount estimated to complete present project		33,500

An appropriation of $33,500 is recommended for the fiscal year ending June 30, 1903.

Should the plan submitted in report of November 24, 1900, for obtaining a channel 18 feet deep be adopted, and an appropriation be made in 1902 for carrying it out, the foregoing estimate of $33,500 for completion of the existing project should be disregarded, as by reference to that report it will be seen that the first item of that estimate provides for the completion of the present approved project.

Money statement.

July 1, 1900, balance unexpended	$8,216.63
June 30, 1901, amount expended during fiscal year	6,134.14
July 1, 1901, balance unexpended	2,082.49
Amount (estimated) required for completion of existing project	33,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	33,500.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

Act of—	
July 13, 1892 (for purchase)	$81,833
August 18, 1894	20,000
June 3, 1896	30,000
March 3, 1899	30,000
Total	161,833

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1900.

[Furnished by Mr. Adam N. Dier, superintendent Sturgeon Bay and Lake Michigan Ship Canal Wisconsin.]

Name, Sturgeon Bay and Lake Michigan Ship Canal, Wisconsin; collection district, Milwaukee, Wis.; nearest light-house, a coast light on the north bank and eastern end of canal. There is also a light at the entrance to the harbor on the north pierhead, one on each side of the canal at harbor or eastern entrance, one on the south side at bay or western entrance, and one on the southerly side at westerly end of the channel dredged in Sturgeon Bay in continuation of the canal proper.

Arrivals and departures of vessels.

Class.	Bound down.		Bound up.		Total.	
	Number.	Net tons.	Number.	Net tons.	Number.	Net tons.
1900.						
Steam	880	455,851	867	399,579	1,747	855,430
Sail	574	80,579	506	66,048	1,080	146,627
Unrigged	306	213,514	320	219,300	626	432,814
Total	1,760	749,944	1,693	684,927	3,453	1,434,871
1899, total	2,015	785,378	1,825	631,734	3,840	1,417,112
1898, total	1,921	669,641	1,855	616,244	3,775	1,285,885

Navigation through the canal for the season of 1900 was resumed April 19, when Green Bay was comparatively clear of ice, and was practically closed December 18, the active or open season being, therefore, two hundred and forty-two days.

Average number of craft passing through canal per day for the whole season (not including tugs)	14.36
Average net tons passing through the canal per day for the whole season (not including tonnage of tugs)	5,933.35
Average net tonnage of—	
Steam craft	489.65
Sail craft	135.76
Unrigged craft	691.39

Statement of freight and passengers carried through the canal during the calendar year ending December 31, 1900.

BOUND DOWN.

Articles.	Net tons.	Articles.	Net tons.
Agricultural implements	847	Merchandise (general)	30,255
Apples	1,097.75	Oils (all kinds)	2,437.43
Brick	30	Piles	158
Cement	3,060	Potatoes	810
Coal and coke	41,203	Salt	12,307.50
Fish	2,471	Staves	990
Flour	2,540	Ties (railroad)	1,540
Hay	219		
Iron (manufactured)	4,822	Total	105,429.68
Lumber	642	Passengers ... number	9,205

BOUND UP.

Agricultural implements	75	Lumber	447,936
Bark	1,408	Merchandise (general)	8,076
Coal and coke	1,975	Paper	525
Dairy products	152	Poles (telegraph)	14,712.14
Fish	952	Posts (fence and paving)	1,611.20
Flour	12,613	Potatoes	93.06
Grain (all kinds)	4,296	Salt	145.50
Hay	401	Stone (building and crib)	202,269
Hides	117	Ties (railroad)	24,350.41
Horses	9	Wood	14,982.50
Iron (manufactured)	25		
Iron (ore)	11,605	Total	753,048.81
Iron (pig)	3,520	Passengers ... number	8,226
Logs	1,200		

Total number of net tons of freight carried through the canal during the calendar year ending December 31, 1900, 858,478.49.

Total number of passengers carried through the canal during the calendar year ending December 31, 1900, 17,431.

Statement showing quantity and estimated value of freight carried through the canal during the calendar year ending December 31, 1900.

Items.	Quantity.	Price per unit.	Total valuation.
Agricultural implements .... tons..	922	$200.00	$184,400.00
Apples .... barrels..	14,673	4.00	58,692.00
Bark .... cords..	1,280	7.50	9,600.00
Brick .... M..	15	10.00	150.00
Cement .... tons..	3,060	30.00	91,800.00
Coal and coke .... do....	43,178	4.50	194,301.00
Dairy products .... do....	152	250.00	38,000.00
Fish .... do....	3,423	100.00	342,300.00
Flour .... barrels..	151,580	4.75	719,767.50
Grain:			
Pease .... bushels..	125,200	1.00	125,200.00
Wheat .... do....	18,000	.75	13,500.00
Hay .... tons..	620	10.00	6,200.00
Hides .... do....	117	130.00	15,210.00
Horses .... number..	12	150.00	1,800.00
Iron:			
Manufactured .... tons..	4,847	62.50	302,937.50
Ore .... do....	11,605	12.00	139,260.00
Pig .... do....	3,520	30.00	105,600.00
Logs .... M feet B. M..	300	15.00	4,500.00
Lumber .... do....	299,052	20.00	5,981,040.00
Merchandise (general) .... tons..	38,331	175.00	6,707,925.00
Oils (all kinds) .... barrels..	10,833	15.00	162,495.00
Paper .... tons..	525	75.00	39,375.00
Piles .... number..	316	7.50	2,370.00
Poles (telegraph) .... do....	86,542	3.00	259,626.00
Posts (fence and paving) .... do....	84,800	.18	15,264.00
Potatoes .... bushels..	30,102	.40	12,040.80
Salt .... barrels..	83,020	1.15	95,473.00
Staves (barrel and tub) .... tons..	990	17.50	17,325.00
Stone (building and crib) .... do....	202,269	.95	192,155.55
Ties (railroad) .... number..	369,863	.28	103,561.64
Wood .... cords..	5,993	5.50	32,961.50
Total value	....	....	15,974,830.49

Comparative statement of principal items of commerce through the canal for the calendar years 1899 and 1900.

Items.	Year.		Increase.	Decrease.
	1899.	1900.		
Vessels .... number..	3,840	3,453	....	387
Tonnage .... tons..	1,417,112	1,434,871	17,759	....
Tonnage (cargo) .... do....	898,394	858,478	....	39,916
Passengers .... number..	14,098	17,431	3,333	....
Apples .... barrels..	12,680	14,673	1,993	....
Bark .... cords..	580	1,280	700	....
Coal and coke .... tons..	19,968	43,178	23,210	....
Fish .... do....	719	3,423	2,704	....
Flour .... barrels..	46,498	151,580	105,082	....
Grain (all kinds) .... bushels..	360,027	143,200	....	216,827
Hay .... tons..	5,386	620	....	4,766
Iron (manufactured) .... do....	4,197	4,847	650	....
Iron (ore) .... do....	26,689	11,605	....	15,084
Iron (pig) .... do....	1,365	3,520	2,155	....
Lumber .... M feet B. M..	373,165	299,052	....	74,113
Merchandise (general) .... tons..	41,525	38,331	....	3,194
Oils (all kinds) .... barrels..	11,675	10,833	....	842
Poles (telegraph) .... number..	109,270	86,542	....	22,728
Posts (fence and paving) .... do....	68,800	84,800	16,000	....
Potatoes .... barrels..	12,120	10,034	....	2,086
Salt .... do....	27,068	83,020	55,952	....
Stone (building and crib) .... tons..	108,855	202,269	93,414	....
Ties (railroad) .... number..	334,100	369,863	35,763	....
Wood .... cords..	14,063	5,993	....	8,070

Estimated value of freight passing through canal during the calendar year ending December 31, 1899	**$17,289,961.25**
Estimated value of freight passing through canal during the calendar year ending December 31, 1900	**15,974,830.49**
Decrease in value of freight in 1900 as compared with 1899	**1,315,130.76**

Statement showing number and net tonnage of tugs passing through the canal during the calendar year ending December 31, 1900, and the number of vessels and unrigged craft towed during that time.

BOUND DOWN.

Month.	Number.	Net tons.	Vessels towed.	Unrigged towed.
April	38	993	2	9
May	45	1,205	22	44
June	78	1,788	10	32
July	92	2,037	15	39
August	95	2,145	11	33
September	77	1,887	20	44
October	88	2,640	13	39
November	74	2,153	12	20
December	18	671	0	4
Total	605	15,519	105	264

BOUND UP.

Month.	Number.	Net tons.	Vessels towed.	Unrigged towed.
April	53	1,228	3	7
May	61	1,656	22	46
June	73	1,716	22	33
July	96	2,182	25	45
August	99	2,378	11	40
September	79	1,940	24	35
October	97	2,858	30	52
November	71	2,115	9	20
December	18	654	3	11
Total	647	16,727	149	289

Total number of trips made through canal by tugs for whole season	1,252
Total number of net tons	32,246
Total number of vessels towed	254
Total number of unrigged craft towed	553
Total number of vessels and unrigged craft towed	807
Average net tonnage of tugs stationed at canal	44.06
Average number passing through canal per day for whole season	5.16
Number of tugs stationed at canal engaged in local towing	5
Net tonnage of tugs stationed at canal for local towing	220
Length of towing route from harbor entrance to mouth of Sturgeon Bay, miles.	8¼

Statement of class and net tonnage of vessels coming in from the lakes via the canal during the year to seek shelter in Sturgeon Bay from storms.

Month.	Steam.		Sail.		Unrigged.		Totals.	
	Number.	Net tons.	Number.	Net tons.	Number.	Net tons.	Number.	Net tons.
January	3	3,098	....	....	....	....	3	3,098
February	3	3,969	....	....	....	....	3	3,969
March	1	890	....	....	....	....	1	890
April	5	1,455	....	....	4	3,100	9	4,555
May	1	90	5	327	....	....	6	417
June	1	209	8	567	....	....	9	776
July	2	324	4	291	3	1,500	9	2,115
August	1	38	21	1,207	3	1,100	25	2,345
September	7	491	27	8,366	14	6,500	48	15,357
October	16	12,037	19	3,764	22	11,900	57	27,701
November	8	2,437	10	1,824	2	800	20	5,061
December	14	4,000	5	1,287	2	1,600	21	6,887
Total	62	29,033	99	17,633	50	26,500	211	73,166

Average net tonnage of steam craft sheltered	468.27
Average net tonnage of sail craft sheltered	178.11
Average net tonnage of unrigged craft sheltered	530

Class, quantity, and estimated value of cargoes carried by vessels while sheltered in Sturgeon Bay, season of 1900, only those coming in from the lake via the canal being included.

Items.	Quantity.	Price per unit.	Total valuation.
Bark .... cords..	537	$7.50	$4,027.50
Coal and coke .... tons..	2,910	4.50	13,095.00
Fish .... barrels..	500	10.00	5,000.00
Flour .... do....	1,500	4.75	7,125.00
Fruit .... bushels..	1,000	1.00	1,000.00
Grain (wheat) .... do....	9,000	.75	6,750.00
Iron:			
Manufactured .... tons..	75	62.50	4,687.50
Ore .... do....	1,440	12.00	17,280.00
Lumber .... M feet B. M..	19,280	20.00	385,600.00
Merchandise (general) .... tons..	1,028	175.00	179,900.00
Poles (telegraph) .... number..	6,600	3.00	19,800.00
Posts (fence and paving) .... do....	16,000	.18	2,880.00
Potatoes .... bushels..	27,000	.40	10,800.00
Stone (building and crib) .... tons..	30,604	.95	29,073.80
Wood .... cords..	2,600	5.50	14,300.00

Total estimated value of cargo carried by craft sheltered	$701,318.80
Total estimated value of vessels sheltered (based on Lloyds's valuation and is approximate)	2,677,550.00
Total value of vessels and cargo	3,378,868.80

Principal lines of transportation using the canal during the past year and number and net tonnage of boats comprising each line.

Name of line.	Port of hail.	Number of boats.	Net tonnage.
Toledo, Ann Arbor and Northern Michigan R. R....	Toledo, Ohio	3	3,969
Lake Michigan Car Ferry Transportation Co........	Chicago, Ill	3	3,384
Goodrich Transportation Co........	.....do	7	5,398
Edward Hines Lumber Co	.....do	6	2,080
John Schroeder Lumber Co	Milwaukee, Wis	3	699
Hart's Steamboat Line	Green Bay, Wis	2	810
Leathem & Smith Towing and Wrecking Co........	Sturgeon Bay, Wis	14	5,039
George Pankratz Lumber Co	.....do	6	3,054
Termensen & Jensen	.....do	5	1,730
Total	....	49	26,163

Of the above lines of transportation, the Toledo, Ann Arbor and Northern Michigan Railroad Company, the Goodrich Transportation Company, and Hart's Steamboat Line carry both freight and passengers; the other lines freight only.

In addition to the above regular lines of transportation, a large number of steam barges, sail vessels, and unrigged craft engaged in the general freighting business make use of the canal continually, going both ways during the season of navigation, and a large local business is done by tugs engaged in assisting sail vessels, unrigged craft, etc., through the canal.

L L 6.

OPERATING AND CARE OF STURGEON BAY AND LAKE MICHIGAN SHIP CANAL, WISCONSIN.

* * * * * * *

Operations have been confined to work incident to operating and care, examinations, keeping record of vessels and tonnage through the canal, and such dredging and repairs as were necessary for maintenance, including the renewal of the south revetment on the rectified line.

The work of rebuilding the revetment on south side of canal was in progress at the beginning of the fiscal year; was suspended for the season November 29, 1900; resumed May 28, 1901, and is in progress at the present time. During the fiscal year 2,312 linear feet of revetment has been rebuilt, of which 410 linear feet has been rebuilt during the present working season. This work has been done by hire of labor and purchase of materials in accordance with law, at a cost, exclusive of dredging, of $7.69 per linear foot, of which $5.71 is for materials and $1.98 for labor. The following is a summary of the materials used:

Round piles	linear feet..	24,324
Pine timber and plank	feet B. M..	418,715
Iron tie-rods, screw bolts, etc	pounds..	46,690
Mudsills (old piles)	linear feet..	2,585

There is about 725 linear feet of the old revetments yet to be renewed; of this amount the materials are now on hand for 425 linear feet, and it is expected that the rebuilding of this portion will be completed during July, 1901. The remaining 300 feet at the easterly end of the canal will have to be of crib construction, as the rock bottom at that locality will prevent the driving of piles. It is not proposed to rebuild this portion at the present time, as considerable rock will have to be excavated before sinking the cribs, and for which there are no funds available.

Dredging for maintenance of channel was done during the months of November and December, 1900, and the month of May, 1901, and a total quantity of 14,419 cubic yards was removed.

During September, 1900, 45 cords of stone were deposited for shore protection and riprap along the harbor front, the stone being furnished and deposited by the Green Stone and Quarrying Company at $5.50 per cord.

Necessary repairs have been made to the pile-driving plant and to the steam launch *Ariadne*. The steam pump on pile driver was thoroughly overhauled and put in good condition at a cost of $48, and the engine of the steam launch was repaired at a cost of $40.

One of the old dump scows belonging to the United States dredging plant was made over into a flat scow. It has since been used for transferring timber, sheet piles, sod, etc., from one part of the canal to another.

The grounds back of the storage warehouse and blacksmith shop were graded and covered with a thick layer of good soil and live sod, and a board fence constructed on the northerly and westerly sides of the premises to protect the sod from drifting sand. Similar improvements were made to a section of the grounds adjacent to easterly side of the office premises.

The huge banks of sand that had accumulated on the premises adjacent to the north harbor front were removed, the grounds graded and covered with a thick layer of good soil and live sod, and a large number of shade and ornamental trees set out.

Other necessary repairs were made to the walks and fences and to the various buildings.

Minor repairs have been made to the revetments where necessary to maintain them in good condition.

Soundings taken at different times during the year showed that the projected depth of water in the canal and in its approaches was well maintained throughout the season of navigation, and while many of the larger vessels touched bottom when deeply laden, no serious groundings occurred during the year.

The minimum stage of water during the year occurred at 6 p. m. January 17, 1901, it then being 2.60 feet below datum; the maximum stage occurred at 4.30 p. m. June 17, 1901, when it was 0.90 foot above datum, the extreme fluctuation during the year being 3.50 feet. The greatest diurnal fluctuation occurred on June 17, 1901, the water at 12 o'clock noon being 0.86 foot below datum, and at 4.30 p. m. 0.90 foot above datum, a range of 1.76 feet. The water thus far this season averages about 0.5 foot higher than during the same period last year.

The regulations governing the use and navigation of the canal were generally well observed, there being only two apparently willful violations during the year, and both cases were promptly reported to the United States district attorney for prosecution.

The revetments were badly damaged twice during the year, once on August 2, 1900, and again on November 20, 1900, by craft in transit colliding with same. The collision of November 20 was the more serious, the revetments on both sides of the canal being badly crushed. The force of the collision wrecked the bow of the scow and it sank with its load of 164 cords of stone. A very strong current carried the stern of the scow around until it came in contact with the south revetment, the scow sinking in a nearly diagonal position across the channel, completely blocking the canal. The wreck was promptly removed by the United States dredges and the damaged revetments repaired. The total cost of removing the wrecked scow and its cargo of stone from the canal and repairing the canal revetments was $1,031.66, of which amount $316.54 was for repairing the canal revetments, the cost of removing the wrecked scow being paid for from an allotment from the appropriation for "Removing Sunken Vessels or Craft Obstructing or Endangering Navigation," Sec. 20, act of March 3, 1899, and of which a special report is made under Removal of Wrecks.

In accordance with the provisions of section 4, river and harbor act of July 5, 1884, a summary of expenditures is herewith given.

Money statement.

July 1, 1900, balance unexpended	$2,476.44
Amount allotted for fiscal year ending June 30, 1901	37,515.54
	39,991.98
June 30, 1901, amount expended during fiscal year	29,943,56
July 1, 1901, balance unexpended	10,048.42
July 1, 1901, outstanding liabilities	1,665.10
July 1, 1901, balance available	8,383.32
Amount[1] (estimated) for expenditure in fiscal year ending June 30, 1902.	8,501.68
Amount available for fiscal year ending June 30, 1902	16,885.00

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[1] Amount allotted if estimate is approved.

Allotments from appropriation for operating and care of canals and other works of navigation, indefinite, act of July 5, 1884, applied to Sturgeon Bay and Lake Michigan Ship Canal, Wisconsin.

May 5. 1893	$1,415.83
July 22, 1893	20,500.00
July 19, 1894	10,301.13
July 20, 1895	12,359.66
August 10, 1896	17,513.84
July 21, 1897	12,873.77
July 28, 1898	27,435.79
September 16, 1898	3,000.00
December 9, 1898	[1]$245.56
July 24, 1899	23,551.29
September 19, 1899	7,500.00
January 27, 1900	1,000.00
July 17, 1900	37,515.54
Total	175,212.41

Summaries of expenditures made from appropriation for operating and care of canals and other works of navigation, indefinite, act of July 5, 1884, applied to Sturgeon Bay and Lake Michigan Ship Canal, Wisconsin, during fiscal year ending June 30, 1901.

Services	$13,758.07
Supplies	2,430.89
Materials	13,693.49
Miscellaneous	61.11
Total	29,943.56

L L 7.

IMPROVEMENT OF STURGEON BAY CANAL, HARBOR OF REFUGE, WISCONSIN.

The original condition of this harbor, object of the improvement, projects, and present works are described in detail in Annual Report Chief of Engineers for 1896, pages 2481 and 2482.

Condition of the improvement.—The main and detached piers are of the full length contemplated. Soundings taken April 15, 1901, showed a channel 17 feet deep below datum with a minimum width of 75 feet. June 30, 1901, the actual depth was 16.2 feet.

Operations during the fiscal year.—By hire of labor and the use of the United States dredging plant, the channel has been maintained during the fiscal year, 8,106 cubic yards of material having been removed and the width of channel increased from 30 feet to 110 feet.

Remarks.—About 550 linear feet of the superstructure of each of the main piers should be rebuilt, and minor repairs made to both the main and detached piers.

Dredging for restoring and maintaining the required depth and width of channel will be necessary. The shoaling in this harbor is considerable, but will doubtless be greatly lessened when the work of widening the canal and renewing the revetments shall be completed, as the greater portion of the material now deposited in the harbor is undoubtedly washed down from the canal banks, while temporarily unprotected during the widening of the canal, and is carried out into the harbor.

The chief benefit derived from the expenditures made during the fiscal year was the maintenance of a channel of the required depth and of navigable width.

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[1] Miscellaneous receipts credited to appropriation.

For the maintenance of channel and piers for the fiscal year ending June 30, 1903, the following estimate is submitted and an appropriation of $14,300 is recommended.

For rebuilding above the water line 1,100 feet of pile pier, at $9	$9,900
For minor repairs to piers	600
For dredging 25,000 cubic yards, at 10 cents	2,500
Contingencies, 10 per cent	1,300
Total	14,300

A consolidation of Sturgeon Bay Canal, harbor of refuge, and Sturgeon Bay and Lake Michigan Ship Canal is recommended for reasons set forth in the annnual report on the latter improvement for 1900, page 3661.

Money statement.

July 1, 1900, balance unexpended	$652.55
June 30, 1901, amount expended during fiscal year	283.74
July 1, 1901, balance unexpended	368.81
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement, in addition to the balance unexpended July 1, 1901 Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	14,300.00

APPROPRIATIONS.

Act of—		Act of—	
March 3, 1873	$40,000.00	July 13, 1892	$5,000.00
March 23, 1874	10,000.00	August 18, 1894	5,000.00
June 18, 1878	30,000.00	June 3, 1896	5,000.00
March 3, 1879	30,000.00	March 3, 1899	5,500.00
June 14, 1880	10,000.00	Miscellaneous receipts credited to appropriations	182.50
March 3, 1881	10,000.00		
August 2, 1882	20,000.00	Total	188,682.50
July 5, 1884	10,000.00		
August 5, 1886	5,000.00		
September 19, 1890	3,000.00		

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1900.

See the statistics with the report on Sturgeon Bay and Lake Michigan Ship Canal, Wisconsin.

L L 8.

IMPROVEMENT OF AHNAPEE HARBOR, WISCONSIN.

The original condition of the mouth of Wolf River, object of the improvement, projects, and present works are described in detail in Annual Report Chief of Engineers for 1896, pages 2483, 2484, and 1899, page 2751.

Condition of the improvement.—The piers were completed the full length contemplated in 1890. Soundings taken June 11, 1900, showed a depth of about 16½ feet below the datum plane of harbor improvements at the harbor entrance and about 13½ feet at the shore end of the piers; thence up the river a distance of about 800 feet rock has been removed to obtain a channel 100 feet wide. About one-third of this area has the required depth of 13 feet and the remaining two-thirds a depth of about 10 feet. The 50-foot channel in continuation of the present channel up the river is not yet of the projected length, nor has it the required depth and width. For a distance of about 520 feet from the head of the present channel it has a depth of 10 feet below the datum plane of harbor improvements with a least width of 30 feet.

The actual governing depth between the piers June 30, 1901, was about 12 feet.

Operations during the fiscal year.—A survey of the harbor was made, a map prepared, and repairs made to the dredging plant.

Remarks.—The pile pier, 350 feet long, at the inshore end of the north pier requires rebuilding above the water surface. Minor repairs to both piers and dredging between them for maintenance of channel will be required.

With the funds available it is proposed to make repairs to the pierhead protection, and minor repairs to the piers the present working season.

Estimate for the fiscal year ending June 30, 1903.

Completion of present project	$19,266
350 feet north pier superstructure, at $10	3,500
20,000 cubic yards dredging, at 12 cents	2,400
Contingencies	2,834
Total	28,000

An appropriation of $28,000 is recommended for the fiscal year ending June 30, 1903. Of this amount $19,266 is for completion of the present project and $8,734 for maintenance of existing works.

Money statement.

July 1, 1900, balance unexpended		$1,621.25
June 30, 1901, amount expended during fiscal year		576.53
July 1, 1901, balance unexpended		1,044.72
Amount (estimated) required for completion of existing project		19,266.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901:		
For works of improvement	$19,266.00	
For maintenance of improvement	8,734.00	
		28,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

APPROPRIATIONS.

Act of—	
March 3, 1871	$25,000
June 10, 1872	25,000
March 3, 1875	25,000
August 14, 1876	8,000
June 18, 1878	8,000
March 3, 1879	7,000
June 14, 1880	7,000
March 3, 1881	8,000
August 2, 1882	12,000
July 5, 1884	15,000
August 5, 1886	15,000
August 11, 1888	$5,000
September 19, 1890	6,000
July 13, 1892	7,000
August 18, 1894	5,000
June 3, 1896	5,000
March 3, 1899	13,000
Miscellaneous receipts credited to appropriations	220
Total	196,220

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1900.

[Furnished by Mr. M. C. Haney, mayor.]

Name of harbor, Ahnapee, Wis.; collection district, Milwaukee, Wis.; nearest light-house, on north pier head, Ahnapee, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	478	260,700	475	250,000
Sail	341	30,000	340	26,500
Total	819	290,700	815	276,500

Exports and imports.

By all ways of transportation.	Tons.	Approximate value.
Exports	78,882	$1,350,000
Imports	68,554.5	950,000

L L 9.

IMPROVEMENT OF KEWAUNEE HARBOR, WISCONSIN.

The original condition of the mouth of the Kewaunee River object of the improvement, projects, and piers built to June 30, 1896, are described in detail in Annual Report of Chief of Engineers for 1896, page 2486. Since then the north pier has been extended 200 feet and the south pier 225 feet.

The piers were completed the full length contemplated by the existing project in 1897, and the dredging in 1898.

Condition of the improvement.—Soundings taken in April, 1901, showed a channel between the piers 15 feet deep below the datum plane of harbor improvements with a width of 200 feet at the entrance and a minimum width of about 90 feet. It is probable that no material change in depth has occurred since that date. The actual depth June 30, 1900, was about 14.2 feet.

One thousand one hundred linear feet of the piers are so much decayed above the water line that renewal is necessary; the remainder of the piers is in good condition.

Operations during the fiscal year.—The dredging plant, consisting of dredges Nos. 1 and 2, five serviceable dump scows, and two tugs, was laid up for the winter at the Government dock, and repairs were made to it at the Government yard that adjoins the dock. These repairs were paid for from appropriations for the improvement of Sheboygan and other harbors, where dredging has already been done, or is to be done, by the Government dredging plant.

Soundings were taken and map prepared showing the condition of the channel.

Remarks.—With the funds available it is proposed to make minor repairs to the south pier the present working season. The renewal above the water line of 450 linear feet of the north pier, built in 1883, and 650 feet of the south pier, built in 1882–1885, is urgently needed; dredging is also necessary for the restoration of the channel.

For the maintenance of existing works, an appropriation of $14,300 is recommended for the fiscal year ending June 30, 1903.

Estimate.

For repairs to 1,100 feet of piers, at $10 per foot	$11,000
For dredging 20,000 cubic yards, at 10 cents	2,000
For contingencies, 10 per cent	1,300
Total	14,300

Money statement.

July 1, 1900, balance unexpended	$561.40
June 30, 1901, amount expended during fiscal year	3.50
July 1, 1901, balance unexpended	557.90
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement, in addition to the balance unexpended July 1, 1901	14,300.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

APPROPRIATIONS.

Act of—		Act of—	
March 3, 1881	$5,000	August 18, 1894	$20,000
August 2, 1882	12,000	June 3, 1896	25,000
July 5, 1884	18,000	March 3, 1899	8,800
August 5, 1886	10,000	Miscellaneous receipts credited to appropriations	14
August 11, 1888	10,000		
September 19, 1890	20,000		
July 13, 1892	30,000	Total	158,814

Appropriated by local authorities in 1881 and expended by the United States under the direction of the engineer officer in charge, $8,042.72.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER, 31, 1900.

[Furnished by Mr. Charles Metzner, mayor.]

Name of harbor, Kewaunee, Wis.; collection district, Milwaukee, Wis.; nearest light-house, on north pierhead, Kewaunee, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	1,056	700,364	1,056	700,364
Sail	180	12,376	180	12,376
Total	1,236	712,740	1,236	712,740

Exports and imports.

By all ways of transportation.	Tons.	Approximate value.
Exports	478,918	$12,678,200
Imports	191,006	2,826,850

L L 10.

IMPROVEMENT OF TWO RIVERS HARBOR, WISCONSIN.

The original condition of the mouth of Twin Rivers, object of the improvement, original project, and present works are described in detail in Annual Report Chief of Engineers for 1896, page 2489, and 1897, pages 2678 and 2679.

The piers were completed the full length contemplated by the existing project in 1884, and the channel dredged to the required dimensions in 1885.

Condition of the improvement.—Beginning at the original shore line, about 1,000 linear feet of each pier is of pile construction and the remaining 750 feet crib work.

The pile piers above the water line are very much decayed and below water so defective as to allow large quantities of sand to pass through them into the channel, making an undue amount of dredging necessary to maintain the required depth. The crib piers, built in 1876–1884, will soon require renewal above the water line.

May 26, 1901, the channel was 13 feet deep below datum for a width of 150 feet, with the exception of a shoal about 100 feet by 100 feet situated in mid-channel just inside the pierheads, over which the minimum depth was 12.3 feet, and four other very small shoals adjacent thereto, with a depth of 12.9 feet.

The actual governing depth June 30, 1901, was 11.5 feet.

Operations during the fiscal year.—Soundings were taken in May, 1901, and a map of the harbor prepared.

Remarks.—With funds now available it is proposed to transfer United States dredge *No. 2* from Sheboygan to Two Rivers and restore the channel to its required depth during the month of July.

As previously stated, the pile piers are much decayed above the water line, and so defective below the water surface as to admit the passage of large quantities of sand through them to the detriment of the channel. The forces that cause the bar formation at the harbor entrance can not be definitely determined until the piers are thoroughly repaired, but it is believed that it is in a large measure due to materials that pass through the piers and are carried by the river current to the harbor entrance and there deposited.

For the fiscal year ending June 30, 1903, the following estimate is submitted for the maintenance of channel and piers:

For 2,000 linear feet of superstructure and repairs to sheet piling, at $8	$16,000
For dredging 40,000 cubic yards, at 12 cents	4,800
For contingencies, 10 per cent	2,080
Total	22,880

Money statement.

July 1, 1900, balance unexpended	$1,323.52
June 30, 1901, amount expended during fiscal year	44.07
July 1, 1901, balance unexpended	1,279.45
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement, in addition to the balance unexpended July 1, 1901	22,880.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

APPROPRIATIONS.

Act of—		Act of—	
March 3, 1871	$25,000	August 2, 1882	$15,000
June 10, 1872	25,000	July 5, 1884	8,000
March 3, 1873	25,000	August 11, 1888	2,500
June 23, 1874	15,000	September 19, 1890	3,000
March 3, 1875	15,000	July 13, 1892	3,000
August 14, 1876	5,000	August 18, 1894	3,000
June 18, 1878	10,000	June 3, 1896	5,000
March 3, 1879	20,000	March 3, 1899	8,000
June 14, 1880	20,000		
March 3, 1881	15,000	Total	222,500

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER, 31, 1900.

[Furnished by Mr. Peter Schroeder, mayor.]

Name of harbor, Two Rivers, Wis.; collection district, Milwaukee, Wis.; nearest light-house, on north pierhead, Two Rivers, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	998	313,990	998	313,990
Sail	116	9,364	116	9,364
Total	1,114	323,354	1,114	323,354

Exports and imports.

	Tons.
By way of the harbor only:	
Exports	118,725
Imports	100,872
By all ways of transportation:	
Exports	254,896
Imports	118,896

L L II.

IMPROVEMENT OF MANITOWOC HARBOR, WISCONSIN.

The original condition of the mouth of Manitowoc River, object of the improvement, projects, and piers built to June 30, 1896, are described in detail in Annual Reports of Chief of Engineers for 1896, page 2491, and 1897, pages 2681 and 2682.

The project adopted in 1896 provided for the formation of a channel 20 feet in depth, to be obtained by extending the south pier 500 feet and by dredging. The former was completed in 1897 and the latter in 1898.

Condition of the improvement.—Soundings taken June 1, 1901, showed the channel to have the required depth of 20 feet below datum for a minimum width of 150 feet. It is probable that no material change has occurred since then. The actual depth of water June 30, 1901, was 19.2 feet. The breakwater is in good condition. Seven hundred and fifty linear feet of the superstructure of the harbor piers, built in 1874–1881, is so much decayed as to render renewal necessary, and minor repairs to the remainder of the piers are required. With the foregoing exceptions the piers are in good condition.

Operations during the fiscal year.—For the purpose of restoring the channel to the required width and depth, work was begun with United States dredge No. 2 August 18 and completed September 28, 1900. During this period 17,270 cubic yards of material were removed from the channel. Soundings were taken in September, 1900, and in June, 1901, and maps of the harbor prepared.

Minor repairs were made to the north pier in November, 1900.

Remarks.—The chief benefit derived from expenditures made during the fiscal year was increasing the width of the 20-foot channel from 100 feet to 180 feet, thereby facilitating entrance to and exit from the harbor.

Attention is invited to reports on examination and surveys as follows:

In accordance with the provisions of act approved March 3, 1899, a survey was made, and report, with plan and estimate of cost, submitted under date of December 12, 1899, for protecting the harbor from the injurious effects of northeast seas. The plan proposed provided for extending the breakwater for a distance of 400 feet in an easterly direction, at an estimated cost of $37,000. (Published in House Doc. No. 233, Fifty-sixth Congress, first session.)

Also, in Annual Report of Chief of Engineers for 1900, pages 3761–3766:

To comply with an item in act approved June 6, 1900, requiring that certain preliminary examinations and surveys be made, which reads as follows:

* * * "Manitowoc Harbor: With a view of making a harbor of refuge with a depth of not less than twenty feet," * * * a preliminary examination was made and report submitted under date of June 23, 1900, to the effect that, inasmuch as there is already a depth of 20 feet at this harbor and a plan approved by the Engineer Department awaiting the action of Congress for extending the breakwater 400 feet, a survey at the present time is considered unnecessary. (Published in House Doc. No. 95, Fifty-sixth Congress, first session.)

The minor repairs now needed to the harbor piers it is proposed to make the present working season.

For the maintenance of existing works for the fiscal year ending June 30, 1903, an appropriation of $11,000 is recommended.

Estimate.

For rebuilding 750 linear feet of superstructure, at $10 per foot	$7,500
For dredging 25,000 cubic yards, at 10 cents per yard	2,500
Contingencies, 10 per cent	1,000
Total	11,000

Money statement.

July 1, 1900, balance unexpended	$3,929.84
July 30, 1901, amount expended during fiscal year	1,952.52
July 1, 1901, balance unexpended	1,977.32
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement, in addition to the balance unexpended July 1, 1901	11,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

APPROPRIATIONS.

Act of—	
August 30, 1852	$8,000.00
June 23, 1866	52,000.00
March 2, 1867	45,000.00
July 25, 1868 (allotted)	17,500.00
April 10, 1869 (allotted)	17,820.00
July 11, 1870	20,000.00
March 3, 1871	11,000.00
March 3, 1873	20,000.00
June 23, 1874	10,000.00
March 3, 1875	10,000.00
August 14, 1876	8,000.00
June 18, 1878	15,000.00
March 3, 1879	6,500.00
June 14, 1880	7,000.00
March 3, 1881	4,000.00
August 2, 1882	$10,000.00
July 5, 1884	15,000.00
August 5, 1886	15,000.00
August 11, 1888	8,000.00
September 19, 1890	8,000.00
July 13, 1892	28,000.00
August 18, 1894	20,000.00
June 3, 1896	44,440.00
March 3, 1899	3,300.00
Miscellaneous receipts credited to appropriations	220.50
Total	403,780.50

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1900.

[Furnished by Mr. Charles B. Roberts, collector of customs, Milwaukee, Wis.]

Name of harbor, Manitowoc, Wis.; collection district, Milwaukee, Wis.; nearest light-house, on north pierhead, Manitowoc, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	1,738	1,702,780	1,731	1,692,587
Sail	365	76,467	358	76,617
Total	2,103	1,779,247	2,089	1,769,204

Application was made to the officials of the city of Manitowoc for the commercial statistics for year 1900, but none were furnished, and those for year ending December 31, 1899, are republished.

Exports and imports.

[Furnished by Mr. William Rahr, mayor.]

	Tons.	Approximate value.
By way of the harbor only:		
Exports	708,092	$2,600,000
Imports	936,407	2,700,000
By all ways of transportation:		
Exports	1,157,052	6,000,000
Imports	1,559,609	5,200,000

L L 12.

IMPROVEMENT OF SHEBOYGAN HARBOR, WISCONSIN.

The original condition of the mouth of Sheboygan River, object of the improvement, projects, and present works, excepting breakwater, are described in detail in Annual Report Chief of Engineers for 1896, page 2495, and 1899, page 2762.

Condition of the improvement.—The south pier is in good condition. The shore end of the north pier is of very inferior construction, and to place it in good order about 1,000 linear feet should be removed and replaced by a pile pier built on rectified line. Each pier requires an extension of about 100 feet to complete the project of 1881.

The breakwater built in 1900 is in good condition. The channel has the required depth of 19 feet below datum. The actual depth June 30, 1901, was 18.2 feet.

Operations during the fiscal year.—Under contract dated December 29, 1899, with Mr. Edward Gillen, of Racine, Wis., for the construction of 600 linear feet of crib breakwater, the work was commenced May 25, 1900, and completed October 13, 1900.

The breakwater consists of 6 cribs, each 100 feet long and 30 feet wide, the two southerly cribs being 27½ feet high and the remaining four cribs 25½ feet high, these heights including the superstructure. The cribs were sunk on a foundation of stone deposited on the lake bottom, filled with stone, and riprapped.

The materials used and cost of same in the work was as follows:

Materials.	Quantities.	Unit price.	Amount.
White-pine timber .... feet B. M..	388,700	$28.00	$10,883.60
Norway-pine timber .... do....	328,848	27.00	8,878.90
Hemlock timber .... do....	438,048	22.00	9,637.06
Pine plank .... do....	6,888	21.00	144.65
Protection piles .... number..	19	12.00	228.00
Stone .... cords..	4,902.2	6.25	30,638.75
Iron driftbolts .... pounds..	88,624	.035	3,101.84
Iron screw bolts .... do....	3,392	.04	135.68
Iron spikes .... do....	6,107	.04	244.28
Total	....	....	63,892.76

By hire of labor and purchase of materials in accordance with law, 50 linear feet of the north pier was rebuilt above the water line, and repairs made to the decking of the north and south piers. Repairs were also made to the dredging plant.

For the purpose of removing an outer bar and shoal places from the channel, work was begun July 21, 1900, and completed August 14, 1900. During this period 7,365 cubic yards of materials were removed by United States Dredge No. 2. At the close of dredging soundings were taken and a map of the harbor prepared. Soundings taken in April, 1901, showed that the bar had again formed, and its removal was begun by Dredge No. 2, May 31, 1901. The dredging was completed June 29, 1901. The total number of cubic yards of material removed during the fiscal year was 20,047.

During the month of June, 1901, the south pier and breakwater were provided with 163.63 cords of stone for filling and riprap at places where undue settlement had occurred.

Remarks.—The project adopted March 3, 1899, provided for the construction of a breakwater 700 feet long, at an estimated cost of $77,000. The act approved March 3, 1899, appropriated $25,000 for the carrying out this project, and authorized a contract "for such materials and work as may be necessary to complete said project, to be paid for as appropriations may from time to time be made by law, not to exceed $52,000 exclusive of the amount herein and heretofore appropriated."

Attention is invited to page 3 of the report dated July 26, 1898, and published in House Doc. No. 53, Fifty-fifth Congress, third session, where it is stated that the estimate of $77,000 was based upon prices paid for materials under the contract then in force for building Milwaukee breakwater. In the year succeeding the date of this report there was a very marked advance in the prices of materials, so that when sealed proposals were opened on October 24, 1899, for the construction of the breakwater, it was found that all bids received exceeded the estimate; whereupon they were rejected as being excessive, the work readvertised and new bids received December 14, 1899. The lowest bid then received still exceeding the estimate, it was impossible to build the entire 700 feet with the amount authorized, and therefore a contract was entered into for the construction of 600 feet of breakwater, which was completed in October, 1900.

It is very desirable that the breakwater should be at least of its full projected length. By referring to the map accompanying the report of July 26, 1898, before mentioned, it will be seen that a proposed extension of 200 feet to the north pier is there shown. It will also be noted in the text of the report that the project for the breakwater was submitted as supplemental to another project as set forth in report of January 27, 1897, and published in House Doc. No. 327, Fifty-fourth Congress, second session. No part of this last-mentioned project has been carried out, nor has the north pier been extended the 200 feet above mentioned, as no appropriations have been made for so doing.

In consequence, the breakwater as now constructed fails to cover the harbor entrance as it was designed to do, and the desired protection of the harbor against "the injurious effect of northeast seas" is not fully attained, more or less sea entering the harbor during northeasterly storms. It is therefore recommended that an additional appropriation be made sufficient to extend the breakwater 100 feet, and thereby complete the present adopted project. Based on the cost of the portion already built, it is estimated that an extension of 100 feet will cost $11,714, this sum including contingencies.

In this connection it may be proper to state that after the breakwater shall have been built to its full projected length of 700 feet and after the harbor piers shall have been extended as proposed in the report of January 27, 1897 (House Doc. No. 327, Fifty-fourth Congress, second session), it may be found that the length of breakwater is still insufficient, and that further extension may then be necessary. But before a definite opinion can be given as to the necessity of an extension beyond the 700 feet contemplated, the projects as laid down in the two reports before mentioned, viz, July 26, 1898 (House Doc. No. 53, Fifty-fifth Congress, third session), and January 27, 1897 (House Doc. No. 327, Fifty-fourth Congress, second session), should be entirely completed and the resulting effects ascertained.

The benefits derived from expenditures made during the fiscal year are the construction of 600 linear feet of breakwater and a resulting partial protection of the harbor from the injurious effects of northeast seas, and the maintenance of channel and piers.

Estimate for the fiscal year ending June 30, 1903.

For completion of existing project for extending each harbor pier 100 feet—200 feet of pier extension, at $65 per foot		$13,000
For maintenance of existing works:		
Removing 1,000 feet of old north pier, at $6 per foot	$6,000	
1,000 linear feet of pile pier, at $20 per foot	20,000	
Minor repairs to piers	1,000	
Dredging for maintenance of channel	4,000	
		31,000
Contingencies		4,400
		48,400

An appropriation of $48,400 is recommended for the fiscal year ending June 30, 1903, of which $14,300 is for completion of existing project, and $34,100 is for maintenance.

Money statement.

July 1, 1900, balance unexpended		$78,415.04
June 30, 1901, amount expended during fiscal year		73,962.15
July 1, 1901, balance unexpended		4,452.89
Amount (estimated) required for completion of existing project		14,300.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901:		
For works of improvement	$14,300.00	
For maintenance of improvement	34,100.00	
		48,400.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and section 7 of the river and harbor act of 1899.		

APPROPRIATIONS.

Act of—		Act of—	
August 30, 1852	$10,000.00	June 14, 1880	$7,000.00
June 28, 1864 (allotted)	10,000.00	March 3, 1881	25,000.00
June 23, 1866	47,598.91	August 2, 1882	30,000.00
March 2, 1867	8,000.00	July 5, 1884	28,000.00
April 10, 1869 (allotted)	14,850.00	August 5, 1886	15,000.00
July 11, 1870	15,000.00	August 11, 1888	15,000.00
March 3, 1871	15,000.00	September 19, 1890	15,000.00
June 10, 1872	18,000.00	July 13, 1892	25,000.00
March 3, 1873	10,000.00	August 18, 1894	25,000.00
June 23, 1874	10,000.00	June 3, 1896	26,000.00
March 3, 1875	12,000.00	March 3, 1899	28,400.00
August 14, 1876	6,000.00	June 6, 1900	52,000.00
June 18, 1878	4,000.00		
March 3, 1879	3,000.00	**Total**	474,848.91

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1900.

[Furnished by Mr. Chas. B. Roberts, collector of customs, Milwaukee, Wis.]

Name of harbor, Sheboygan, Wis.; collection district, Milwaukee, Wis.; nearest light-house, Sheboygan, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	798	592,449	798	594,066
Sail	298	43,032	301	43,509
Total	1,096	635,481	1,099	637,575

Application was made to the officials of the city of Sheboygan for the commercial statistics for year 1900, but none were furnished, and those for year ending December 31, 1899, are republished.

Exports and imports.

[Furnished by Mr. E. P. Ewer.]

By all ways of transportation:	*Tons.*
Exports	466,328
Imports	575,671

L L 13.

IMPROVEMENT OF PORT WASHINGTON HARBOR, WISCONSIN.

The original condition of the mouth of Sauk River, object of the improvement, projects, and present works, are described in detail in Annual Report of the Chief of Engineers for 1896, page 2499.

Condition of the improvement.—The piers were completed in 1893. The channel and basins had, with minor exceptions, the required depth of 13 feet at the close of dredging in 1895, and the object of the improvement was then practically obtained.

Since then the expenditures have been for maintenance. The piers are in fair condition, minor repairs only being required. Soundings taken June 12, 1901, showed the required depth of 13 feet below datum in the entrance channel and basins.

The actual depth of water June 30, 1901, was 12.2 feet.

Operations during the fiscal year.—Dredging by hire of labor and the use of United States Dredge No. 2 was begun June 19, 1900, and completed July 18. During this period 9,231 cubic yards of material were excavated, of which amount 4,510 cubic yards were removed during the fiscal year, resulting in the removal of an outer bar and restoring the entrance channel and basins to a depth of 13 feet. Soundings were taken July 19, 1900, and June 12, 1901, and maps of the harbor prepared.

Remarks.—The benefits derived from the expenditures made during the fiscal year were the restoration of the entrance channel and basins to the depth and dimensions required by the existing project, thereby rendering navigation less difficult for vessels entering or departing from this harbor. For the maintenance of existing works for the fiscal year ending June 30, 1903, an appropriation of $4,400 is recommended.

Estimate.

For dredging 25,000 cubic yards, at 12 cents	$3,000
For minor repairs to piers	1,000
For contingencies, 10 per cent	400
Total	4,400

Money statement.

July 1, 1900, balance unexpended	$1,874.40
June 30, 1901, amount expended during fiscal year	766.54
July 1, 1901, balance unexpended	1,107.86
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement in addition to the balance unexpended July 1, 1901	4,400.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

APPROPRIATIONS.

Act of—	
July 11, 1870	$15,000.00
March 3, 1871	15,000.00
June 10, 1872	15,000.00
March 3, 1873	15,000.00
June 23, 1874	10,000.00
March 3, 1875	10,000.00
August 14, 1876	8,000.00
June 18, 1878	5,000.00
March 3, 1879	7,500.00
June 14, 1880	20,000.00
March 3, 1881	17,000.00
August 2, 1882	17,000.00
July 5, 1884	10,000.00
August 5, 1886	$5,000.00
September 11, 1888	5,000.00
September 19, 1890	3,000.00
July 13, 1892	6,500.00
August 18, 1894	5,000.00
June 3, 1896	5,500.00
March 3, 1899	4,400.00
Miscellaneous receipts credited to appropriations	36.50
Total	198,936.50

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1900.

[Furnished by Mr. C. O. Larson, harbor master.]

Name of harbor, Port Washington, Wis.; collection district, Milwaukee, Wis.; nearest light-house, on outer end of north pier, Port Washington, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.	Departures.
Steam	60	60
Sail	40	40
Total	100	100

Exports and imports.

	Tons.	Approximate value.
By way of the harbor only:		
Exports	9,767.5	$400,600
Imports	43,989	1,300,000
By all ways of transportation:		
Exports	94,355.5	3,800,000
Imports	66,762	2,000,000

L L 14.

IMPROVEMENT OF HARBOR OF REFUGE AT MILWAUKEE, WISCONSIN.

The original condition of Milwaukee Bay, object of the improvement, project, and breakwater built to June 30, 1896, are described in detail in Annual Report, Chief of Engineers for 1896, page 2502. Since then the main arm of the breakwater has been extended 2,600 feet by cribs 30 feet wide, making the total length of the main arm at the present time 4,800 feet, all of which is provided with superstructure.

Condition of the improvement.—Soundings taken in August and September, 1898, showed a depth of water along main arm varying from 25 feet at the angle to 35 feet at southerly end. Area covered by present works: Outside 12-foot contour, 407 acres; outside 19-foot contour 289 acres.

Operations during the fiscal year.—Under contract dated June 7, 1899, with Mr. Robert B. Rice, of Muskegon, Mich., for the construction of 900 linear feet of substructure and 3,100 linear feet of superstructure, more or less, work was in progress at the beginning of the fiscal year, and since then 2 cribs, each 100 feet long, and 1 crib 68 feet long have been built and sunk in place, and 2,800 linear feet of continuous timber superstructure has been built. All work under this contract was completed on December 3 and the contract closed.

The materials used and cost of same in the work were as follows:

Materials.	Quantities.	Unit price.	Amount.
White pine timber ......feet B. M..	1,812,536	$22.00	$28,875.79
Norway pine timber ......do....	677,304	21.00	14,223.38
Hemlock timber ......do....	675,216	16.00	10,803.46
Relaying timber ......do....	285,076	2.50	712.69
Pine plank ......do....	11,040	17.00	187.68
Stone ......cords..	12,900.5	5.15	66,437.58
Iron driftbolts ......pounds..	224,220	.03	6,726.60
Iron screw bolts ......do....	16,666	.03	499.98
Iron spikes ......do....	29,227	.03	877.57
Total	......	......	129,844.78

Cost of substructure per linear foot, $87.87; cost of superstructure per linear foot, $16.21; total, $104.08.

By hire of labor and the purchase of materials in accordance with law, a mooring station was provided near the southerly end of the breakwater, thereby affording a place for tugs to lie while awaiting the arrival of vessels to be towed either into the harbor or the harbor of refuge.

Minor repairs were made to the superstructure of the older portions of the breakwater.

Remarks.—The breakwater is now of the full contemplated length, and is provided with a continuous timber superstructure, thus completing the original project of 1881. Extensive repairs to the old portions of the superstructure are, however, urgently demanded. The north or shore arm, about 2,450 feet long, was built in 1881–1885, and the superstructure is now in a dangerous condition.

In this connection attention is invited to pages 2768 and 2769, Part IV, of Annual Report Chief of Engineers for 1899, where the great necessity of making these repairs at as early a date as possible is set forth and the substitution of concrete in place of timber in the superstructure is recommended.

The superstructure of the northerly 1,000 feet of the main arm of the breakwater, being that portion lying north of the "fair weather opening," so called, was built in 1887–1889, and is also in a much decayed condition, though not as badly so as is the shore arm superstructure, it having been built about four years later. Owing to the more exposed situation of this portion of the breakwater, however, its condition is now even more dangerous than is that of the shore arm. It is therefore recommended that this portion of the breakwater also be provided with a concrete superstructure.

The estimated cost of the proposed work is as follows:

2,450 linear feet shore arm, 14,000 cubic yards, at $8.50	$119,000
1,000 linear feet main arm, 6,000 cubic yards, at $8.50	51,000
Contingencies, superintendence, etc	17,000
	187,000

An opening 400 feet wide, known as the "fair weather opening," has been left in the breakwater, its purpose being to afford an entrance and exit to and from the harbor in fair weather. As a matter of fact, large vessels seeking shelter in the harbor do not use this passage; it is mostly used by small pleasure craft and excursion steamers.

Currents setting in from Lake Michigan not only produce scour through this opening, but carry sand into the harbor, and a shoal is forming immediately to the south of the opening inside of the breakwater. This shoal is increasing from year to year, and while at the present time there is a sufficient depth of water over it, it is believed that if the currents through the opening continue it will eventually become necessary to dredge that a necessary depth be maintained.

Furthermore, this opening renders that part of the harbor opposite to it practically useless during a storm, and also makes the southerly 3,800 feet of the breakwater a detached work. Access to the light at its southerly end can only be had by boat, and this becomes impossible during a heavy storm.

It therefore appears that the disadvantages of the opening greatly outweigh any slight benefits that it may be to the small craft that occasionally use it, and that so far as the general commerce of the lakes is concerned it is of no benefit whatever. It is therefore recommended that when the concrete superstructure shall have been built to the opening and before beginning work on the detached portion the opening be closed and the superstructure made continuous.

In the report of the Board of Engineers constituted to consider and report on plan "for improving Milwaukee Bay for purposes of harbor of refuge," and published in Annual Report, Chief of Engineers for 1881, page 2122, occurs the following:

> * * * Should it be found, when the main arm of the breakwater has been completed, that increased protection of the interior of the harbor of refuge against southeast gales is advisable, it is proposed to secure it either by extending this main arm until it intersects the prolongation of the north pier, or by putting in a covering breakwater * * * and nearly closing the interval between the south end of the main breakwater and the north river pier.

To extend the main arm until it intersects the prolongation of the north pier would require the building of about 2,550 linear feet of breakwater. Such an extension is not only believed to be unnecessary but inadvisable, as it would make access to the harbor of refuge more difficult for vessels coming from the north.

But an extension of 1,000 feet would not only afford increased protection in the harbor of refuge against southeast gales, as well as increased anchorage ground, but additional protection would be given to the harbor entrance at the mouth of the Milwaukee River. Complaints have been made of severe oscillations in the inner harbor of Milwaukee during northeasterly storms, on account of which vessels moored to wharves near the harbor entrance have been compelled to move farther up the river. It is believed that not only would an extension to the breakwater of, say, 1,000 feet greatly improve conditions in this respect, and thereby increase the harbor facilities of Milwaukee, but it is known from observation that such an extension would make entrance to the harbor during northeasterly gales much safer and easier.

Repairs will have to be made from time to time in order to strengthen those parts of the superstructure which show indications of failure. But such repairs will be of a very temporary nature, as it is believed that permanent repairs should be made with concrete. The funds now available are sufficient for such temporary repairs.

It is therefore urgently recommended that an appropriation of $187,000 be made for the fiscal year ending June 30, 1903, in order that the very important work of renewing the superstructure can be commenced in the near future.

Money statement.

July 1, 1900, balance unexpended	$118, 841. 44
June 30, 1901, amount expended during fiscal year	98, 132. 15
July 1, 1901, balance unexpended	20, 709. 29
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement, in addition to the balance unexpended July 1, 1901	187,000. 00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

APPROPRIATIONS.

Act of—		
March 3, 1881		$100, 000. 00
August 2, 1882		100, 000. 00
July 5, 1884		85, 000. 00
August 5, 1886	$60, 000. 00	
From which allotted to Milwaukee Harbor	4, 737. 91	
		55, 262. 09
August 11, 1888		70, 000. 00
September 19, 1890		80, 000. 00
July 13, 1892		75, 000. 00
August 18, 1894		45, 000. 00
June 3, 1896		20, 000. 00
June 4, 1897		168, 737. 91
March 3, 1899		50, 000. 00
June 6, 1900		105, 650. 00
Miscellaneous receipts credited to appropriations		1, 000. 00
Total		955, 650. 00

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1900.

Name of harbor, Harbor of Refuge, Milwaukee, Wis.; collection district, Milwaukee, Wis.; amount of revenue collected at nearest port of entry, $423,604.34.

(See the commercial statistics for Milwaukee Harbor, Wisconsin.)

L L 15.

IMPROVEMENT OF MILWAUKEE HARBOR, WISCONSIN.

The original condition at the mouth of Milwaukee River, the object of the improvement, projects, and present works, are described in detail on page 2506, Part IV, Annual Report of the Chief of Engineers for 1896.

Project of 1899.—The project adopted March 3, 1899, provides for the formation and maintenance of a channel 21 feet deep below the datum plane of harbor improvements, the minimum width of channel between the piers to be 200 feet, and the width outside the pierheads to be 600 feet.

Condition of the improvement.—The harbor piers were completed to their projected length in 1872. Soundings taken April, 1901, showed a channel midway between the piers with a least width of 180 feet and 21 feet deep below the datum plane of harbor improvements.

The actual depth June 30, 1901, was 20.2 feet.

Operations during the fiscal year.—To complete the requirements of an item in section 2 of act approved June 6, 1900, which reads as follows:

> Milwaukee Harbor: With a view to necessary enlargement and suitable protection therefor,

a preliminary examination was made and report submitted under date of August 6, 1900. The report is published in House Doc. No. 86, Fifty-sixth Congress, second session, and concludes as follows:

> For the foregoing reasons, therefore, the improvement of the locality by the General Government in the manner contemplated by the act of June 6, 1900, is not advisable.

Remarks.—The funds now available are believed to be sufficient for maintenance of channel and for such repairs to the piers as may become necessary, except the renewal of the stone superstructure of the inner portion of the north pier. The condition of this stone superstructure and the method proposed for its renewal were fully described in Annual Report of the Chief of Engineers for 1900, page 3698, and an estimate of the cost of such renewal was submitted.

Since submitting this estimate a tendency of the pier to settle toward the channel, due to the undermining of the cribs, has been observed. This pier was built by the city of Milwaukee and was composed of cribs 32 by 20 by 17 feet, sunk upon a clay bed dredged to a depth of 12 feet. As under the present project a channel depth of 21 feet is now maintained, the bottoms of these cribs are now 9 feet or more above the bottom of the channel.

Before building a permanent concrete superstructure it will be, therefore, necessary to protect the cribs from further undermining. It is proposed to accomplish this by building a substantial sheet pile revetment along the channel face of the pier. This revetment is then to be cut down at least 3 feet below datum, the space between it and the pier to be filled with stone, and a concrete superstructure built over the pier and revetment.

This proposed work not only adds to the amount of the previous estimate by the cost of the revetment, but also involves an increase in the section of the concrete superstructure and a corresponding increase in cost. For the rebuilding of this superstructure the following estimate is submitted:

1,050 linear feet sheet pile revetment	$19,000
Removing old stone superstructure and cutting down cribs	5,000
6,000 cubic yards concrete, at $8.50	51,000
Contingencies, superintendence, etc	7,500
Total	82,500

At the present time there are 19 works of improvement, exclusive of the Fox River, located at 15 different harbors in this district, and which are distributed along the west shore of Lake Michigan and Green Bay between Waukegan, Ill., and Menominee, Mich., representing a coast line of nearly 300 miles. While all of these harbors are accessible by railway the route to some of them is circuitous and the train service poor, involving numerous delays and much loss of time.

Much difficulty has also been experienced in hiring suitable vessels for making various examinations and surveys that have been ordered from time to time by act of Congress, and in making examinations and surveys of uncharted reefs and shoals, and similar work.

It is believed that both the inspection and survey work of this district would be greatly benefited were a suitable steam vessel provided. Such a vessel should have cabin accommodations for a survey party in addition to quarters for the crew, and be provided with all necessary arrangements so that a survey party could live aboard the boat. It should be large enough to carry a small amount of material—timber, iron, etc.—that might be needed for making urgent repairs of a minor nature, and be provided with engines of power sufficient to make not less than 12 miles per hour.

It is estimated that a steam vessel suitable for the foregoing purposes can be built and fully equipped for $30,000. As Milwaukee is the most important harbor in this district, as well as the district headquarters, the headquarters of the boat should be there likewise, and it is recommended that the sum of $30,000 be added to the appropriation for Milwaukee Harbor, Wisconsin, for constructing a suitable steam vessel for inspection and survey purposes in this district.

An appropriation of $112,500 is recommended for the fiscal year ending June 30, 1903, of which $82,500 is for maintenance and $30,000 is for an inspection and survey boat.

Money statement.

July 1, 1900, balance unexpended	$8,566.52
June 30, 1901, amount expended during fiscal year	25.75
July 1, 1901, balance unexpended	8,540.77
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement, in addition to the balance unexpended July 1, 1901 Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	112,500.00

APPROPRIATIONS.

Expended on former mouth of Milwaukee River.

Act of—

July 4, 1836	$400.00
March 3, 1843	30,000.00
June 11, 1844	20,000.00

Straight cut.

Act of—

August 30, 1852	$15,000.00
March 3, 1853	163.94
June 23, 1866	48,283.51
April 10, 1869 (allotted)	35,640.00
July 11, 1870	40,000.00
March 3, 1871	38,000.00
March 3, 1873	10,000.00
March 23, 1874	10,000.00
March 3, 1875	25,000.00
August 14, 1876	26,000.00
June 18, 1878	15,000.00
March 3, 1879	7,500.00
June 14, 1880	10,000.00
March 3, 1881	8,000.00
August 2, 1882	10,000.00
August 5, 1886 (from appropriation for harbor of refuge)	4,737.91
August 11, 1888	10,000.00
March 17, 1890 (special act)	6,100.00
September 19, 1890	6,000.00
July 13, 1892	14,000.00
August 18, 1894	7,000.00
June 3, 1896	7,000.00
March 3, 1899	26,000.00
Total expended at old river mouth and straight cut	429,825.36
Expended at former mouth of Milwaukee River	50,400.00
Total appropriated for straight cut (present harbor)	379,425.36

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1900.

[Furnished by W. J. Langson, secretary Chamber of Commerce, Milwaukee, Wis.]

Name of harbor, Milwaukee, Wis.; collection district, Milwaukee, Wis.; amount of revenue collected during the year, $423,604.34.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	4,751	4,716,478	4,751	4,729,827
Sail	1,022	309,761	1,032	316,072
	5,773	5,026,239	5,783	5,045,899

Exports and imports.

	Tons.
By way of the harbor only:	
Exports	1,072,892
Imports	2,630,348
By all ways of transportation:	
Exports	2,672,940
Imports	4,746,995

L L 16.

IMPROVEMENT OF SOUTH MILWAUKEE HARBOR, WISCONSIN.

See Annual Report of the Chief of Engineers for 1900, page 3701.
There were no operations during the fiscal year ending June 30, 1901.

Money statement.

July 1, 1900, balance unexpended	$277.16
June 30, 1901, amount expended during fiscal year	70.00
July 1, 1901, balance unexpended	207.16
Amount (estimated) required for completion of existing project	133,000.00

APPROPRIATION.

Act of June 3, 1896	$5,000

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1900.

[Furnished by Mr. Fred. W. Rogers, secretary South Milwaukee Company.]

Name of harbor, South Milwaukee, Wis.; collection district, Milwaukee, Wis.; nearest light-house, north pier, Milwaukee, Wis.

Exports and imports.

By all ways of transportation.	Tons.	Approximate value.
Exports	66,678	$3,000,000
Imports	869,102	3,100,000

L L 17.

IMPROVEMENT OF RACINE HARBOR, WISCONSIN.

The original condition of the mouth of Root River, object of the improvement, projects, and piers built to June 30, 1898, are described in detail in Annual Report of Chief of Engineers for 1896, pages 2511 and 2512, and for 1898, page 2330.

Project of 1899.—The project adopted March 3, 1899, provides for extending the south pier 300 feet, building 600 feet of breakwater, and dredging to widen channel and to increase the depth in same to 21 feet below the datum plane of harbor improvements.

Condition of the improvement.—Soundings taken May 17, 1901, showed a channel with a least width of 140 feet and depth of 20.3 feet below datum. It is probable that no material change has occurred since then. The actual depth June 30, 1901, was 19.5 feet.

Operations during the fiscal year.—Under contract dated June 9, 1899, with Mr. Samuel O. Dixon, of Racine, Wis., operations were continued to November 9, 1900, when the work was completed and the contract closed, resulting in dredging 113,478 cubic yards of material; the transfer of 152.8 cords of stone from the old north pier to the new work, and tearing out 200 linear feet of old pier and dock

The total operations under this contract and the cost of same were as follows:

Dredging 192,030 cubic yards, at 8.8 cents	$16,898.64
Removing 1,000 linear feet of old pier and dock for the sum of	5,950.00
Transferring 302.2 cords of stone from the old to the new work, at $3.50 per cord	1,058.05
Total	23,906.69

Under contract dated June 7, 1899, with Mr. Robert B. Rice, of Muskegon, Mich., operations were continued until December 3, 1900, when the work was completed and the contract closed, resulting in building five cribs, each 100 feet long, and sinking them in place, thereby extending the breakwater 500 feet, and building 600 feet of breakwater superstructure. Under this contract a breakwater 600 feet long was built, and the south pier extended 300 feet. The materials used and cost of same in place were as follows:

Materials.		Quantities.	Unit price.	Amount.
White pine timber	feet B. M.	481,030	$22.50	$10,823.17
Norway pine timber	do	430,608	21.50	9,258.10
Hemlock timber	do	589,380	16.50	9,724.77
Pine plank	do	23,306	17.00	396.23
Stone	cords	6,060.6	5.50	33,333.30
Iron drift bolts	pounds	117,790	.03	3,533.70
Iron screw bolts	do	4,613	.03	138.39
Iron spikes	do	5,378	.03	161.34
Foundation and protection piles	number	160	10.00	1,600.00
Total				68,969.00

Cost of breakwater per linear foot, $89.16.
Cost of south pier extension per linear foot, $51.58.

By hire of labor and purchase of materials in accordance with law, 520 linear feet of the north pier was rebuilt above the water line, 500 linear feet of plank walk renewed, and minor repairs made to both of the harbor piers. Soundings were taken at the close of dredging in November, 1900, and May 17, 1901, and map of the harbor prepared.

Remarks.—The chief benefits derived from expenditures made during the fiscal year were, first, completion of the 21-foot channel; second, completion of the breakwater to prevent injurious effects of northeast seas; third, renewal above the water line of 520 linear feet of the north pier.

Arrangements have been made for building additional protection to the south pierhead, and for furnishing about 180 cords of stone for filling and riprapping the cribs at places where undue settlement had occurred.

Soundings taken in May, 1901, indicate that since the completion of the dredging in November, 1900, a deposit of about 1 foot, beginning at the harbor entrance and extending westerly about 500 feet, has occurred. This shoaling is not sufficient to justify redredging at present, but it may become necessary before the close of the present working season. The funds available are believed to be sufficient to maintain the existing works to June 30, 1902.

Seven hundred and forty feet of the south pier is so much decayed as to render its renewal above the water line necessary, and 300 feet of it was so imperfectly constructed as to admit of the free passage of sand through it into the channel; the cribs were sunk on the natural lake bottom and settled very unevenly, causing large openings at the end of each crib. This section of the pier should be made impervious to the passage of sand by a line of sheet piling, reenforced with round piles.

Estimate.

Rebuilding 740 feet of superstructure, south pier, at $7	$5,180
Building 300 feet sheet piling, south pier, at $12	3,600
Dredging for maintenance of channel, 40,000 cubic yards, at 12 cents	4,600
Contingencies	1,320
Total	14,900

An appropriation of $14,900 for the maintenance of existing works is recommended for the fiscal year ending June 30, 1903.

Money statement.

July 1, 1900, balance unexpended	$87,774.82
June 30, 1901, amount expended during fiscal year	82,087.73
July 1, 1901, balance unexpended	5,687.09
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement, in addition to the balance unexpended July 1, 1901 Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	14,900.00

APPROPRIATIONS.

Act of—		Act of—	
June 15, 1844	$12,500	June 14, 1880	$6,000
August 30, 1852	10,000	March 3, 1881	6,000
June 28, 1864	3,600	August 2, 1882	7,000
June 23, 1866	23,910	July 5, 1884	7,000
March 2, 1867	45,000	August 5, 1886	10,000
April 10, 1869 (allotted)	22,275	August 11, 1888	10,000
July 11, 1870	10,000	September 19, 1890	17,500
March 3, 1871	10,000	July 13, 1892	25,000
March 3, 1873	20,000	August 18, 1894	20,000
June 23, 1874	10,000	June 3, 1896	27,000
March 3, 1875	10,000	March 3, 1899	50,000
August 14, 1876	8,000	June 6, 1900	67,650
June 18, 1878	10,000		
March 3, 1879	6,000	Total	454,435

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1900.

[Furnished by Mr. Michael Higgins, mayor of Racine, Wis.]

Name of harbor, Racine, Wis.; collection district, Milwaukee, Wis.; nearest port of entry, Milwaukee, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	1,573	1,168,556	1,569	1,168,543
Sail	220	40,390	226	44,738
Total	1,793	1,208,946	1,795	1,213,281

Exports and imports.

	Tons.	Approximate value.
By way of the harbor only:		
Exports	108,566	$2,450,000
Imports	237,835	4,750,000

L L 18.

IMPROVEMENT OF KENOSHA HARBOR, WISCONSIN.

The original condition of the mouth of Pike Creek, object of the improvement, projects, and piers built to June 30, 1898, are described in detail in Annual Report of the Chief of Engineers for 1896, page 2516, and for 1898, page 2333.

Project of 1899.—The project adopted March 3, 1899, provides for extending the south pier 525 feet, removing and rebuilding the north pier from shore to 21-foot contour, so as to obtain a width at entrance of 250 feet, building 600 feet of breakwater, increasing depth in channel and basin to 21 feet and 20 feet, respectively, below the datum plane of harbor improvements, and widening channel between the piers.

Condition of the improvement.—Both piers and the breakwater have been built to their full projected length, and the entrance channel and basin have been dredged to the projected depths of 21 feet and 20 feet, respectively, thus completing the present project.

Soundings taken in June, 1901, showed a channel between the piers 21 feet deep, with a least width of 170 feet, and a depth of 20 feet in the basin over an area of about 3 acres, these depths being below the datum plane.

The actual depth of water in the channel June 30, 1901, was 20.2 feet.

Operations during the fiscal year.—Under contract dated June 10, 1899, with James Cape & Sons, of Racine, Wis., for building 925 linear feet of pile pier, the work was completed June 30, 1900. In July final payment was made and the contract closed. The following materials were used in the construction of this pier:

Materials.	Quantities.	Price.	Amount.
Round piles .... linear feet..	38,470	$0.17	$6,539.90
Wakefield sheet piling .... feet B. M..	182,960	27.50	3,656.40
Pine plank .... do....	23,640	20.00	472.80
White oak timber .... do....	58,440	39.00	2,279.16
Pine timber .... do....	33,480	27.00	903.97
Stone .... cords..	696.09	6.00	4,176.54
Stone [a] .... do....	1,809.30	3.50	6,332.55
Wrought-iron screw bolts and tie-rods .... pounds..	30,184	.04	1,207.36
Iron spikes .... do....	2,708	.04	108.32
Total	....	....	24,677.00

[a] Not included in James Cape & Sons' contract.

Cost per linear foot, $26.68.

Under contract dated June 10, 1899, with Mr. Samuel O. Dixon, of Racine, Wis., for dredging, removing old pier, and moving cribs, work was in progress at the beginning of the fiscal year, and was completed October 30 and the contract closed. The following work was done under this contract during the fiscal year: Dredging 180,793 cubic yards, tearing out and removing 517 linear feet of old pier, transferring 946.3 cords of stone, and moving 3 cribs from old north pier and placing them in new pier. The total work done and cost of same under this contract is as follows:

Dredging 381,590 cubic yards, at 6 $\frac{9}{10}$ cents	$26,329.70
Transferring 1,952.3 cords of stone, at $3.50	6,833.05
Removing 1,500 feet, more or less, of old pier	9,750.00
Moving 3 cribs, each 50 by 24 feet by 22½ feet	7,000.00
Total	49,912.75

Under contract dated June 9, 1899, with Mr. Robert B. Rice, of Muskegon, Mich., for building 600 linear feet of breakwater and extending the south pier 500 linear feet, work was in progress at the beginning of the fiscal year, but no cribs had been sunk at that time. The work, consisting of 6 cribs, each 100 by 30 feet by 27½ feet on stone foundation, forming the breakwater, and of 5 cribs, each 100 feet by 24 feet by 22½ feet on pile foundation, forming the south pier extension, was completed December 3 and the contract closed. The total quantities of materials used and cost of same in place are as follows:

Materials.	Quantities.	Price.	Amount.
White pine timber .... feet B. M.	557,456	$22.50	$12,542.76
Norway pine timber .... do	536,208	21.50	11,528.47
Hemlock timber .... do	799,776	16.50	13,196.30
Pine plank .... do	41,682	17.00	708.59
Foundation and protection piles .... number	280	10.00	2,800.00
Drift bolts .... pounds	152,490	.03	4,574.70
Screw bolts .... do	3,174	.03	95.22
Spikes .... do	5,904	.03	177.12
Stone .... cords	7,535.91	5.65	42,577.89
Total			88,201.05

Cost of breakwater per linear foot, $96.
Cost of south pier extension, per linear foot, $61.20.

By hire of labor and purchase of materials in accordance with law, 362 linear feet of the south pier superstructure was rebuilt above the water line, and minor repairs made to the decking and plank walk of the south pier. The work was begun October 11 and completed December 19, 1900. The total quantities of materials used and cost of same, including labor, was as follows:

78,528 feet B. M. pine timber, at $18 to $23 per M	$1,494.34
6,720 feet B. M. pine plank, at $17 per M	114.24
6,910 pounds of drift bolts, at $1.85 per cwt	127.83
43 pounds of screw bolts, at $1.85 per cwt	.80
300 pounds of spikes, at $1.85 per cwt	5.55
Labor, including pay of overseer	936.94
Total	2,779.70

Cost per linear foot, $7.40.

Remarks.—The present project is now completed, and it is believed that ample provision has been made for all present requirements of commerce at this harbor. Dredging will, however, be necessary from time to time in order to maintain the projected depth in channel and basin, and repairs to the superstructure of the older portions of the south pier will be required. But the balance available from previous appropriations for the improvement of this harbor is considered to be sufficient to maintain existing works to June 30, 1903, and therefore no appropriation for that purpose is recommended.

Since the completion of the project for a 21-foot channel, masters of vessels have complained of a current setting across the harbor entrance from north to south, during storms from a northeasterly direction, and which appear to sweep around the northerly end of the breakwater. It may become necessary at some time in the future to extend the breakwater, but it is uncertain as yet whether an extension toward the north would be of any benefit. If it should be shown that the current is due to the waves receding from the beach being reflected from the breakwater, an extension toward the north might be injurious. In that case an extension in line with the north pier might be of benefit. But until more definite knowledge of the causes of the current is obtained it would be advisable to make no extension of the breakwater.

Money statement.

July 1, 1900, balance unexpended	$153,315.03
June 30, 1901, amount expended during fiscal year	137,096.08
July 1, 1901, balance unexpended	16,218.95

APPROPRIATIONS.

Act of—		Act of—	
March 15, 1844	$12,500.00	March 3, 1881	$5,000.00
March 3, 1845	15,000.00	August 2, 1882	6,000.00
August 13, 1852	10,000.00	July 5, 1884	5,000.00
June 23, 1866	75,461.41	August 5, 1886	5,000.00
April 10, 1869 (allotted)	5,346.00	August 11, 1888	7,500.00
July 11, 1870	10,000.00	September 19, 1890	17,500.00
March 3, 1871	10,000.00	July 13, 1892	15,000.00
June 10, 1872	10,000.00	August 18, 1894	15,000.00
June 23, 1874	10,000.00	June 3, 1896	24,000.00
March 3, 1875	15,000.00	March 3, 1899	50,000.00
August 14, 1876	8,000.00	June 6, 1900	135,000.00
June 18, 1878	8,000.00		
March 3, 1879	5,000.00	Total	484,307.41
June 14, 1880	5,000.00		

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1900.

[Furnished by Mr. H. S. Van Ingen.]

Name of harbor, Kenosha, Wis.; collection district, Milwaukee, Wis., nearest port of entry, Milwaukee, Wis.; nearest light-house, Kenosha, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	318	79,506	313	79,090
Sail	137	26,802	141	28,359
Total	455	106,308	454	107,449

Exports and imports.

	Tons.	Approximate value.
By way of the harbor only:		
Exports	11,943.5	$250,000
Imports	86,456	1,700,000
By all ways of transportation:		
Exports	68,584.5	17,000,000
Imports	436,577.5	11,000,000

MOVING CRIBS AT KENOSHA HARBOR, WISCONSIN.

The project for obtaining a 21-foot channel at Kenosha Harbor, Wisconsin, provided for an increase in the distance between the piers, making the width of entrance 250 feet instead of 165 feet. This necessitated the removal of the entire north pier and the construction of a new one. With the exception of the three outer cribs, the old north pier was in such a dilapidated state as to be utterly valueless, and it was torn to pieces, the piles, timber, and iron composing it being broken up and disposed of as waste material, and such stone as could be saved being used in the new work,

The three outer cribs were built in 1893 and 1895, and were in good serviceable condition, and it was therefore determined to move them to the outer end of the new pier. No similar work had ever been done in this district, and there was no information to be found of any similar work done elsewhere. It was therefore with some uncertainty as to results that the work was entered upon. The successful results attained and the lack of previous information on the subject are believed to warrant a description of the work and of the methods employed.

The specifications provided that "the three outer cribs * * * that form the outer end of the present north pier shall be taken up and moved to the outer end of the new pile pier, where they shall be placed on a foundation of piles, driven and cut off to receive them, * * * refilled with stone, decked, and riprapped. The old foundation piles shall be entirely removed from the present site of the cribs, and shall be disposed of in the same manner as the piles and timber for the old north pier.

"The price bid for moving cribs shall be for the entire work as above set forth, and the new foundation piles shall be furnished and driven, and such additional stone, decking, or other material as may be required shall be furnished, secured in the work by the contractor, without additional expense to the United States."

The contract was awarded to Mr. S. O. Dixon, of Racine, Wis., for $7,000. The same party had the contract for tearing out the old north pier and for dredging in the channel and basin, and was well equipped with the necessary plant and appliances for doing such work.

The cribs were each 50 feet long, 24 feet wide, and 22½ feet high, and rested on a pile foundation. The accompanying plan of the crib shows its general construction and the arrangement of the piles constituting the foundation. It will be noted that the central portion of the crib is provided with a floor 13 feet wide, and that the outer portions or pockets have no bottom. In sinking a crib, stone was thrown into the middle pocket until the crib rested on the piles, when the outside pockets were filled, the stone running through them and spreading out on the bottom; after which the sides of the crib were riprapped about as shown. The piles for foundation were cut off at a horizontal plane 16½ feet below datum, and the deck of the completed crib was 5 feet above datum.

Before attempting to move the cribs, the deck plank were all taken up and the stone removed to the water surface. The riprap was then all removed, and a deep trench dug along each side and partly under the cribs, a dredge being employed for these purposes, the idea being that the stone in the side pockets would fall into this trench, from which it could be subsequently removed. The stone in the side pockets, however, formed an arch which it became necessary to break before the stone would fall into the pockets, a pile driver being used for this purpose.

After the riprap and stone from side pockets had been entirely removed two dump scows were moored along side of the crib, one on each side. These scows were each 120 feet long, 28 feet wide, and 10 feet 6 inches deep, and had a carrying capacity of 420 cubic yards of wet sand, or about 630 tons. The dump scows were then employed in connection with the dredge and were not specially provided for this purpose.

It will be noted on the plan of the crib that the walls are 1 foot below the tops of foundation piles. In order to safely clear the piles, and to allow for the crib not being exactly level when lifted, it was necessary to lift the crib about 2 feet. Assuming that the crib was raised 2 feet, the amount to be lifted was approximately as follows:

	Pounds.
Pine timber	73,440
Limestone	669,714
Wrought iron	5,866
Total	749,020

or approximately 375 tons.

This calculation is based on the assumption that the submerged timber of the crib had a specific gravity of 1, as it would barely float, being thoroughly water-soaked. The specific gravity of limestone was taken at 2.7, and of wrought iron at 7.77. The weight of pine timber was assumed to be 40 pounds per cubic foot for the amount above water.

The total capacity of the two scows was about 1,260 tons when loaded so that their decks were awash. If it is assumed that their capacity was only half as great, or 630 tons, when their decks were 2 feet above the water surface, it will be seen that there was an ample lifting force provided, being 255 tons in excess of that calculated to be necessary.

Three Howe trusses were placed across each scow and over the crib, one truss being across the center of the crib and the other two at the ends. The arrangement of these trusses can be seen from the accompanying photographs. The trusses were built of Washington fir timber and were each 10 feet high. The chords were 14 by 14 inches by 72 feet in one piece, and the braces 10 by 14 inches. The trusses were quite roughly made at the locality where used, and the joints were not cut with much care, consequently they settled somewhat when loaded, but satisfactorily performed the work for which they were designed. They were supported at the ends by a blocking built up of 12 by 12 inch timbers on each scow, so that when the scows were sunk the trusses just cleared the crib.

Stirrups were hung from the lower chords of the trusses, one stirrup on each side of each crib wall. Four stirrups were used to each truss, or twelve to each crib. These stirrups were made of two pieces of 1⅜-inch round Norway iron, the upper ends passing through the lower chord and an iron plate placed on top of same, and the lower ends passing through an iron plate, both ends of each rod being through and provided with nuts; the screw ends were not enlarged. Heavy blocks of timber 30 inches long were placed under the walls of the crib and through the stirrups, a diver being employed to fasten the lower plates to the rods and place the timber blocks in position; the upper nuts were then tightened.

Before placing the stirrup blocks under the crib walls, the scows were allowed to fill with water until their decks were awash. Three holes, each 3 inches square, were cut in the bottom of each scow, two holes at one end and one at the other, through which water was admitted. It was noticed these holes did not admit water sufficiently fast to sink the scow rapidly, and larger holes would have been better. But as the scows formed part of the dredging plant, the contractor was naturally loth to cut much larger holes or more of them.

After the scows were sunk in place and the trusses and stirrups adjusted, the holes in the bottom were closed and the scows pumped out. This lifted the crib which was then suspended between the scows. In pumping out, a steam pump with 6-inch suction was placed on each scow, and in addition thereto three 3-inch syphons were employed. The scows were sunk, and the trusses and stirrups adjusted in the evening. Pumping out was commenced early on the following morning, and the crib was lifted, moved, and sunk in position the same day.

In sinking the crib it was brought into position so as to be over the new foundation piles, which had been previously driven and cut off, when the holes in the bottoms of the scows were opened and they gradually sank. After the crib was resting on the pile foundation, the nuts at the upper ends of the stirrups were loosened, a diver then removed the timber blocks and bottom plates, the rods were withdrawn, and the scows carrying the trusses were placed in position for moving the next crib.

The work was very successfully and satisfactorily done, no serious accidents or delays occurring. It was noticed, however, during the sinking of one of the cribs, after it was resting on the foundation piles, but before all of the nuts at the upper ends of the stirrups could be unscrewed, that the water in Lake Michigan suddenly rose. In consequence, a heavy strain was suddenly brought upon the nuts still holding, and in most cases the threads were stripped, the nuts flying 15 or 20 feet. As Lake Michigan is subject to these sudden fluctuations, when the water will rise or fall a foot in a few minutes, it is believed that in further operations of this sort in that locality it would be well to provide some form of wedge, similar to those used in striking heavy arch centers, so that in case of a sudden rise in the water, the wedges could be knocked out, relieving the stirrups from the sudden strains and shocks that would otherwise be brought upon them.

The total time consumed in moving these cribs was ten days, this not including the time required for partially emptying them of stone, nor for the subsequent refilling and riprapping. The plant employed consisted of one large dipper dredge having a capacity of 200 to 300 cubic yards per hour, a floating pile driver, two tugs, and two dump scows, together with necessary appliances, such as pumps, syphons, etc. To the efficiency of this plant and the intelligent management and direction displayed by the contractor is due the success of the work.

(Note: Plan[1] of crib in separate roll.)

L L 19.

IMPROVEMENT OF WAUKEGAN HARBOR, ILLINOIS.

The original condition at Waukegan Harbor, object of the improvement, projects, and present works are described in detail in Annual Report of Chief of Engineers for 1896, pages 2519 and 2520, and for 1897, page 2706.

Condition of the improvement.—Both piers were completed the full projected length in 1895, and the dredging in 1897. Since then the expenditures have been for repairs and maintenance. June 18, 1901, the channel between the piers had a depth of 13 feet below datum for a minimum width of about 150 feet, within which there was a depth of 17 feet, with a least width of 90 feet. The latter channel was excavated by the city authorities of Waukegan, the Elgin, Joliet and Eastern Railway Company, and the Western Coal and Dock Company. The actual depth of water June 30, 1901, in those channels was about 12.2 feet, and 16.2 feet, respectively.

Operations during the fiscal year.—Not any.

Remarks.—Attention is invited to reports on a preliminary examination and a survey dated April 18, 1899, and January 5, 1900, respectively, submitting plans for obtaining a channel 20 feet deep, at an estimated cost of $345,000, published in House Doc. No. 343, Fifty-sixth Congress, first session; also in Annual Report of Chief of Engineers for 1900, pages 3769–3775.

Two hundred and sixty linear feet of the south pier is so much decayed above the water line as to require immediate renewal. Proposals have been invited for furnishing the materials needed, and delivery of same on or before July 20, 1901, and it is proposed to make these repairs immediately thereafter with funds now available.

The channel excavated by the city authorities of Waukegan and private parties in 1899 was redredged by them in 1900, and again during the months of May and June, 1901. During this latter period they reported the removal of 26,357 cubic yards of material.

For the maintenance of existings works for the fiscal year ending June 30, 1903, an appropriation of $7,700 is recommended.

Estimate.

For dredging 20,000 cubic yards, at 15 cents	$3,000
For the renewal above the water line 400 feet of the south pier, at $10 per foot	4,000
For contingencies, 10 per cent	700
Total	$7,700

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[1] Not printed.

NOTE.—Should the plan submitted in report dated January 5, 1900, for obtaining a depth of 20 feet be adopted and an appropriation be made in 1902 for carrying it out, the foregoing estimate of $7,700 for maintenance should be disregarded, as the estimate for a 20-foot channel provides for the repairs of pier, and dredging for maintenance would not be required in 1903.

Money statement.

July 1, 1900, balance unexpended	$4,765.38
June 30, 1901, amount expended during fiscal year	11.52
July 1, 1901, balance unexpended	4,753.86
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement, in addition to the balance unexpended July 1, 1901	7,700.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

APPROPRIATIONS.

Act of—	
August 30, 1852, for breakwater (outer)	$15,000
June 14, 1880	15,000
March 3, 1881	15,000
August 2, 1882	20,000
July 5, 1884	20,000
August 15, 1886	20,000
August 11, 1888	25,000
September 19, 1890	35,000
July 13, 1892	25,000
August 18, 1894	20,000
June 3, 1896	20,000
March 3, 1899	5,500
Total appropriation for harbor	235,500
Appropriation for outer breakwater (1852)	15,000
Total for present harbor	220,500

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1900.

[Furnished by Mr. F. Finer, mayor.]

Name of harbor, Waukegan, Ill.; collection district, Chicago, Ill.; nearest lighthouse, Waukegan, Ill.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	380	130,439	380	130,439
Sail	367	22,825	367	22,825
	747	153,264	747	153,264

Principal articles of export and import.

	Tons.	Approximate value.
By way of the harbor only:		
Exports	300	$2,900
Imports	86,910	1,496,500
By all ways of transportation:		
Exports	337,530	11,196,800
Imports	941,799.5	13,000,500

LL 20.

IMPROVEMENT OF FOX RIVER, WISCONSIN.

The original condition, object of the improvement, projects, etc., are fully described in Report of the Chief of Engineers, 1898, p. 2339.

During the past year the water in the Lower Fox and Lake Winnebago has been maintained at the crest of the dams throughout the season of navigation. This favorable condition has now prevailed for five consecutive seasons, due to the enforcement of rule 12, Rules and Regulations for the Navigation and Use of Locks and Canals on Fox River. No serious violations of these rules occurred during the year, and no arrests were necessary. Apparently all parties along the river are coming to recognize the value of these rules, when impartially enforced, in protecting the rights of each and promoting the best interests of all.

Attention is invited to the report upon "Operating and care of locks and dams on Fox River, Wisconsin;" also accompanying hydrographs,[1] etc., showing stages of water, etc.

During the fiscal year ending June 30, 1901, navigation closed November 21, 1900, and reopened April 25, 1901.

Operations during the fiscal year.—The work done during the year consisted in dredging the channels to 6 feet on the Upper Fox, and providing a navigable channel, 100 feet wide and 6 feet deep at mean low water in accordance with the approved project. At the close of the last fiscal year the channel had been completed up to a point 300 feet above milepost 43, or about 500 feet above White River lock, with the exception of a section 2½ miles long between milepost 34 and 37, where dredges were then working. The work done during the year was in continuation of the channel at this point. On August 15 the work was discontinued for lack of funds.

Remarks.—The survey of the United States works of improvement on Fox River, and of lands appertaining thereto, referred to in last annual report, was completed in March, 1901, and the maps, 36 in number, will be found valuable in construction of future works and for reference in any proceedings for the settlement of land questions on Fox River.

July 10, 1899, a revocable license was granted by the Secretary of War permitting the Neenah and Menasha Water Power Company to place 8-inch flushboards on the Menasha Dam on conditions previously agreed to by the company in writing.

Flushboards were placed by the company May 29, 1900, and removed October 5 and 6, 1900; placed December 14, 1900, and removed February 25, 1901; placed June 10, 1901, removed June 12; placed June 14, removed June 17, and placed June 24, when water was 8 inches above the crest and falling.

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[1] Not printed.

I have to renew the recommendation for the purchase of a chain-bucket dredge with conveyor. It is believed that this apparatus will not only materially reduce the present cost of dredging, but also hasten the completion of the work. With the existing plant it is often necessary to rehandle dredged materials two or three times, and to purchase the right to deposit it when the dredge banks are on private property. With the proposed dredge such rehandling would be unnecessary, and the dredged material could be distributed evenly over the adjacent land, instead of in high and unsightly mounds. So deposited this rich soil would be an advantage to property owners.

The estimate for this dredge is $40,000.

For carrying out the approved project it is recommended that $100,000 be appropriated for the fiscal year ending June 30, 1903, including $40,000 required for the purchase of a chain bucket dredge with conveyor.

Money statement.

July 1, 1900, balance unexpended	$9,271.51
June 30, 1901, amount expended during fiscal year	2,346.19
July 1, 1901, balance unexpended	6,925.32
Amount (estimated) required for completion of existing project	153,366.48
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement in addition to the balance unexpended July 1, 1901	100,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

List of appropriations made by Congress for the improvement of the Fox and Wisconsin rivers, Wisconsin.

Act of—	
March 2, 1867, for snag boat on Wisconsin River	$40,000
July 10, 1870, for improving Wisconsin River	100,000
June 10, 1872, for purchase of works on Fox River from Green Bay and Mississippi Canal Company	145,000
March 3, 1873, for improving Fox and Wisconsin rivers	300,000
June 23, 1874	300,000
March 3, 1875	500,000
August 14, 1876	270,000
June 18, 1878	250,000
March 3, 1879	150,000
June 14, 1880	125,000
March 3, 1881	125,000
August 2, 1882	200,000
July 5, 1884	160,000
August 5, 1886, for improving Fox River	56,250
August 11, 1888, for improving Fox River	100,000
September 19, 1890, for improving Fox River	100,000
July 13, 1892, for improving Fox River	75,000
August 18, 1894, for improving Fox River	37,500
June 3, 1896, for improving Fox River	37,500
March 3, 1899, for improving Fox River	27,500
Miscellaneous receipts from sale of tug *Gen. G. K. Warren*	1,000
Total	3,099,750

COMMERCIAL STATISTICS.

List of articles transported on Fox River, Wisconsin, during the season of 1900.

Articles.	Quantity.	Articles.	Quantity.
	Tons.		*Tons.*
Apples	75	Lumber	10,240
Beer	56	Oil (kerosene)	37.5
Brick	10,026.5	Paper	82
Carriages	6	Pig iron	45
Cedar posts	322.5	Pulp wood	12,860
Cement	16.5	Salt	705.5
Coal	17,399	Sand	12,600
Cord wood	22,218	Sewer pipe	800
Drain tile	50	Shingles	638
Flour, feed, and grain	2,099	Shingle bolts	120
General merchandise	1,535	Slab wood	60
Hay	2,497	Stone	2,043.5
Land plaster	80	Rags	62
Lath	81		
Lime	302	Total	309,800.5
Logs	212,743.5		

Passengers, 34,415.

List of boats navigating Fox River between Portage and Green Bay, Wis., 1901.

Name of boat.	Draft in feet.	Tonnage.	Class.	Name of boat.	Draft in feet.	Tonnage.	Class.
H. K. Priest	2½	90	Steamboat.	Sandy	4	200	Tow barge.
J. H. Marston	5	75	Do.	H. K. Priest	3½	50	Do.
Fashion	3	56	Do.	H. K. Priest	3½	90	Do.
Thistle	2	100	Do.	Long Tom	5	200	Tow scow.
John Lynch	3	50	Do.	Jumbo	5½	150	Do.
Evelyn	3	150	Do.	Taylor	6	200	Do.
B. F. Carter	5	210	Do.	Pelton	6	200	Do.
John Denessen	5	15	Steam tug.	Anna M	2½	10	Steam yacht.
Nettie Denessen	5	24	Do.	Okoboji	4½	10.99	Do.
H. O. Warren	5	15	Do.	Cambria	4		Do.
Volunteer	5½	17	Do.	Gazelle	3½		Do.
M. D. Moore	3	53.96	Do.	Irma	3½		Do.
D. L. Libbey	3	50	Do.	Nia	3½		Do.
Wm. Finch	5½	49	Sailing scow.	Swallow	3½		Do.
Georgia	5½	78	Do.				

NOTE.—There are also a number of small pleasure yachts besides those mentioned.

Number of lockages on Fox River, Wisconsin, for the calendar year 1900.

No.	Lock.	Lockages.	No.	Lock.	Lockages.
1	Depere	482	16	Appleton second	256
2	Little Kaukauna	326	17	Appleton first	411
3	Rapide Croche	297	18	Menasha	431
4	Kaukauna fifth	314	19	Eureka	494
5	Kaukauna fourth	312	20	Berlin	313
6	Kaukauna third	314	21	White River	145
7	Kaukauna second	334	22	Princeton	167
8	Kaukauna first	334	23	Grand River	227
9	Little Chute fourth *a*	314	24	Montello	132
10	Little Chute third *a*	314	25	Governor bend	51
11	Little Chute second	276	26	Fort Winnebago	6
12	Little Chute first	275	27	Portage	7
13	Cedars	200			
14	Appleton fourth	246		Total	7,251
15	Appleton third	273			

a Combined.

REPORT OF MR. L. M. MANN, ASSISTANT ENGINEER.

U. S. ENGINEER OFFICE, FOX RIVER IMPROVEMENT,
Oshkosh, Wis., June 30, 1901.

CAPTAIN: I have the honor to submit the following report of operations on "Improving Fox River, Wisconsin," from Portage to Green Bay, for the fiscal year ending June 30, 1901.

The work done during the year consisted only in dredging channel, Upper Fox River.

DREDGING UPPER FOX.

Dredging was carried on for providing a navigable channel, 100 feet wide and 6 feet deep at mean low water, in accordance with the approved project. At the close of the last fiscal year the channel had been completed up to a point 300 feet above mile post 43, or about 500 feet above White River lock, with the exception of a section 2½ miles long between mileposts 34 and 37, where dredges were then working. The work done during the year was in continuation of the channel at this point. Dredges Nos. 2 and 4 were engaged from July 1 and Dredge No. 5 from July 19. On August 15 the work was discontinued, the money available being expended. The channel was extended 1¾ miles, leaving a section of ¾ mile between mileposts 34 and 35 still incomplete.

The following is a summary of the work done (see also tabulation of dredging accompanying report):

Between mileposts.	Summary of cuts.			Material (dipper measurement).		Character of material dredged.	Number of dredge working.
	Length.	Average width.	Average depth.	Handled.	Rehandled.		
	Feet.	*Feet.*	*Feet.*	*Cu. yds.*	*Cu. yds.*		
34-35	2,640	15-60	1-6	8,357	1,784	s and c	2,4 and 5
35-36	10,270	10-60	1-4	31,303	4,270	s and c	2,4 and 5
36-37	7,813	12-60	1-4	32,005	7,280	s and c	2 and 4
Total	20,723	10-60	1-6	71,765	13,334		

NOTE.—"s" represents sand, and "c" clay.

Respectfully submitted.

L. M. MANN,
Assistant Engineer.

Capt. JAMES G. WARREN,
Corps of Engineers, U. S. A.

Data respecting dredging done on Fox River, Wisconsin, for the calendar year 1900.

[Compiled under the direction of Capt. J. G. Warren, Corps of Engineers, United States Army, by L. M. Mann, assistant engineer.]

No. of dredge.	Location of dredging.	Material.						Time.		
		Handled.	Rehandled.	Scowed.	Rehandled.	Depth dredged.	Character of material.	Employed.	Worked.	Lost.
		Cubic yards.	*Cubic yards.*	*Cubic yards.*	*Per cent.*			*Dys.*	*Hrs.*	*Hrs.*
2	Upper Fox River	38,764	6,030	......	15.55	1 to 5	Sand, clay, and stone.	51½	356	56
4	.....do	59,787	16,999	......	28.43	½ to 4	Sand and clay	74	562	30
5	.....do	49,901	8,190	......	16.41	1 to 8	Sand, clay, and mud.	70	490	62
2	Lower Fox River	4,165	361	......	8.66	1 to 7	Clay, stone, and hardpan.	19	141	11
4	.....do	2,790	....	......	....	½ to 2	Clay and stone	9	49	23
5	.....do	7,572	....	......	....	1 to 2	Clay	13	98	6
	Totals and averages	162,979	31,580	......	....	½ to 8	....	236½	1,696	188

Data respecting dredging done on Fox River, Wisconsin, etc.—Continued.

No. of dredge.	Location of dredging.	Distribution of cost.								Material handled per day of 8 hours.
		Running repairs.	General repairs.	Fuel.	Sundries.	Crew.	Towing.	Superintendence.	Total.	
										Cu. yds.
2	Upper Fox River	......	$550.14	$254.60	$12.68	$738.57	$109.20	$85.60	$1,750.79	871.1
4	.....do	$3.25	1,680.87	413.91	16.35	971.72	270.46	172.53	3,529.09	850.9
5	.....do	5.99	1,398,47	210.37	11.36	784.79	329.70	140.88	2,881.56	814.7
2	Lower Fox River	......	437.43	100.84	5.02	272.49	40.30	44.01	900.09	263.3
4	.....do	......	204.46	36.08	1.43	118.18	32.90	20.21	413.26	455.5
5	.....do	......	259.72	42.08	2.27	145.76	61.23	26.28	537.34	618.7
	Totals and averages.	9.24	4,531.09	1,057.88	49.11	3,031.51	843.79	489.51	10,012.13	768.7

No. of dredge.	Location of dredging.	Cost per cubic yard.								Appropriation.
		Running repairs.	General repairs.	Fuel.	Sundries.	Crew.	Towing.	Superintendence.	Total.	
2	Upper Fox River	....	$0.0141	$0.0065	$0.0003	$0.0190	$0.0028	$0.0022	$0.0451	(*a*)
4	.....do	$0.00005	.0281	.0069	.0003	.0162	.0045	.0028	.0590	(*b*)
5	.....do	.00012	.0278	.0042	.0002	.0157	.0066	.0028	.0577	(*a*)
2	Lower Fox River	....	.1050	.0242	.0012	.0654	.0096	.0105	.2161	(*c*)
4	.....do	....	.0732	.0129	.0005	.0423	.0117	.0072	.1481	(*c*)
5	.....do	....	.0343	.0055	.0003	.0192	.0081	.0034	.0709	(*c*)
	Totals and averages.	.00005	.0278	.0064	.0003	.0186	.0051	.0030	.0614	

a Operation, care, and improvement. *b* Improvement. *c* Operation and care.

NOTE.—Dipper measurement is used in estimating quantities dredged.

The work on Upper Fox consisted in dredging channel according to project. (See separate table.)

The work on Lower Fox consisted in deepening and widening channel according to project. (See separate table.)

The work at Appleton Third Lock consisted in removing cofferdam above and below lock.

The work at Fort Winnebago Lock consisted in throwing up cofferdam below lock.

Under "General Repairs" is included cost of crew fitting and laying up dredge.

General repairs include cost of repairs of dump scows Nos. 1 and 2 and 50-foot wood scows.

Amounts under "Towing" include, also, cost of crew for taking soundings while attending dredges and otherwise.

The following is not included in above, being work otherwise than regular dredging. (See note.)

No. of dredge.	Location of dredging.	Material.						Time.		
		Handled.	Rehandled.	Scowed.	Rehandled.	Depth dredged.	Character of material.	Employed.	Worked.	Lost.
		Cubic yards.	*Cubic yards.*	*Cubic yards.*	*Per cent.*			*Dys.*	*Hrs.*	*Hrs.*
2	Appleton Third Lock	2,361	....	......	....	1 to 7	Clay and hardpan.	10	68	17
5	Fort Winnebago Lock	375	....	......	....	....	Sand	2	10	6
7	Not in commission	....	....	......	....	....	....	....	....	....
	Totals and averages.	2,736	....	......	....	1 to 7	....	12	78	23

No. of dredge.	Location of dredging.	Distribution of cost.								Material handled per day of 8 hours.
		Running repairs.	General repairs.	Fuel.	Sundries.	Crew.	Towing.	Superintendence.	Total.	
										Cu. yds.
2	Appleton Third Lock	......	$106.84	$45.06	$2.25	$143.42	$21.22	$16.87	$335.66	299.8
5	Fort Winnebago Lock	......	39.97	4.30	.23	22.44	9.41	3.93	80.28	300.1
7	Not in commission	......	....	....	....	....	....	....	....	....
	Totals and averages.	......	146.81	49.36	2.48	165.86	30.63	20.80	415.97	299.8

No. of dredge.	Location of dredging.	Cost per cubic yard.								Appropriation.
		Running repairs.	General repairs.	Fuel.	Sundries.	Crew.	Towing.	Superintendence.	Total.	
2	Appleton Third Lock	....	$0.0452	$0.0190	$0.0009	$0.0607	$0.0089	$0.0071	$0.1421	(a)
5	Fort Winnebago Lock	....	.1065	.0114	.0006	.0598	.0250	.0104	.2140	(a)
7	Not in commission	....	....	....	....	....	....	....	....	
	Totals and averages	....	.0536	.0180	.0009	.0606	.0111	.0076	.1520	

a Operation and care.

NOTE.—The average cost per cubic yard is in excess of the last previous years, caused by dredges working a short season, and a greater part of the repairs for the following season are included in this account.

L L 21.

OPERATING AND CARE OF LOCKS AND DAMS ON FOX RIVER, WISCONSIN.

* * * * * * *

The work during the fiscal year consisted principally in dredging bars and channels in the river; making repairs of locks, dams, canal banks, lock houses, dredges, and boats; rebuilding Appleton second lock, waste weir, and wall; completing dry dock at Kaukauna, and survey of United States works and property along Fox River.

The old second lock at Appleton, constructed of concrete, with thin facing of masonry, having so far deteriorated as to be unsafe, was replaced with a permanent and substantial structure of cut stone laid in cement at a cost of $23,000.

For details of work done during the year see the report of Mr. L. M. Mann, assistant engineer, appended to this report. His report is accompanied by one tracing, hydrograph of Lake Winnebago, discharge of Fox River, and rainfall.

It is again particularly to be noted that the continued enforcement of the rules and regulations for the navigation and use of the locks and canals on Fox River, approved by the Secretary of War, under the river and harbor act of August 18, 1894, has brought about a general condition which is far more satisfactory than ever before to all interests concerned.

An itemized statement of the expenditures during the year, required by section 4, river and harbor act of July 5, 1884, is appended hereto.

Money statement.

July 1, 1900, balance unexpended	$13,306.16
Amount allotted for fiscal year ending June 30, 1901	84,427.05
	97,733.21
June 30, 1901, amount expended during fiscal year	66,552.85
July 1, 1901, balance unexpended	31,180.36
July 1, 1901, outstanding liabilities	3,830.66
July 1, 1901, balance available	27,349.70
Amount (estimated) for expenditure in fiscal year ending June 30, 1902[1].	54,563.57
Amount available for fiscal year ending June 30, 1902	81,913.27

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[1] Amount allotted if estimate is approved.

List of allotments from appropriation for operating and care of canals and other works of navigation, indefinite, act of July 5, 1884, applied to Fox River, Wisconsin.

August 9, 1884	$54,000.00
July 28, 1885	42,304.00
July 20, 1886	43,668.00
July 13, 1887	43,650.00
June 28, 1888	48,900.00
June 12, 1889	62,760.00
November 25, 1889	13,500.00
June 19, 1890	69,005.00
April 28, 1891	63,980.00
July 1, 1892	40,000.00
July 15, 1893	32,430.55
July 26, 1894	30,882.37
July 20, 1895	61,279.63
October 6, 1896	62,665.03
July 30, 1897	60,009.62
July 29, 1898	$63,869.10
October 4, 1898	3,000.00
July 22, 1899	72,911.29
January 6, 1900	2,000.00
May 29, 1900	6,362.54
July 20, 1900	78,167.11
August 10, 1900	6,238.40
October 15, 1900, miscellaneous receipts credited to appropriation	15.84
May 29, 1901, miscellaneous receipts credited to appropriation	15.70
Total	961,604.18

Summaries of expenditures made from appropriation for operating and care of canals and other works of navigation, indefinite, act of July 5, 1884, applied to Fox River, Wisconsin, during fiscal year ending June 30, 1901.

Services	$44,839.01
Supplies	2,304.00
Materials	18,569.40
Miscellaneous	840.44
Total	66,552.85

REPORT OF MR. L. M. MANN, ASSISTANT ENGINEER.

United States Engineer Office,
Fox River Improvement,
Oshkosh, Wis., June 30, 1901.

Captain: I have the honor to submit the following report of operations upon "operating and care of canals and other works of navigation on Fox River, Wisconsin," from Portage to Green Bay, for the fiscal year ending June 30, 1901.

The work done during the year consisted principally in making repairs to Portage levee and lock, waste weir near Fort Winnebago; partly rebuilding Fort Winnebago lock; repairing Montello lock and dam and Grand River dam; repairing Berlin lock, lock house, and shops; repairing Menasha lock house and channel cribs; repairing Appleton upper dam and revetment wall; rebuilding Appleton second lock; repairing Appleton third-lock crib wall and fourth-lock house; repairing Little Chute second-lock head wall and canal banks; repairing Little Chute combined locks and waste weir; repairing Kaukauna locks and dam; completing construction of Kaukauna dry dock and shops; repairing Rapide Croche dam; dredging bars and channels; special repairs to dredging plant; general repairs to locks, dams, and canal banks; general repairs to plant, boats, and dredges; care of works and property, and completing survey of United States property on Fox River.

MAINTENANCE OF NAVIGATION.

Navigation closed formally November 1, 1900, through the Appleton Canal to permit work to be commenced on Appleton second lock. Water was shut off from Appleton levels on November 14, 1900. Navigation was formally closed on the Fox and Wolf rivers, November 21, 1900. * * * Navigation was again opened April April 25, 1901. * * *

The water in the Lower Fox and Lake Winnebago has been well maintained at the crest of the dams throughout the year, and no arrests for infringement of rule 12 of the regulations, etc., were necessary.

The stage in Lake Winnebago was below the crest of the Menasha dam only during 55 days, the least on record; last year it was below the crest 197 days. Of these 55 days it was below the crest during the navigation season only 14 days, viz, in July, 1900, the remaining 41 days occurring in February and March, 1901, during the close of navigation.

The mills had closed down on June 18, and again commenced drawing 10 per cent of "first water" on July 14, when water had reached the crest. The mills at Neenah and Menasha were allowed on October 27, 1900, by the honorable the Secretary of War, to draw the water 18 inches below the crest during the close of navigation. The mills husbanded the water very closely, and the lowest point reached was only 7 inches below the crest for two days in March, 1901; it again reached the crest March 27, 1901. During the low water of July, 1900, the water was more than 1 inch below the crest only six days, and the maximum amount below, 2½ inches, occurred only for three days.

The stages of Lake Winnebago are shown on hydrograph accompanying this report, with discharge as observed at Rapide Croche dam and precipitation of the upper valleys. Hydrograph shows:

Water below crest of Menasha dam	days..	55
Water at or above crest of Menasha dam	do....	310
Maximum height, May 15, 1899		+3.25
Maximum height, November 22, 1900		+2.87
Maximum height, April 13, 1901		+3.17
Lowest point reached, March 16, 1901		+1.17
Mean high water for 19 years		+3.05

Maximum discharge of river measured at Rapide Croche dam, which gives the whole flow practically, was—

575,798 cubic feet per minute, November 3, 1900.

721,952 cubic feet per minute, April 12, 1901.

The latter is the largest discharge recorded in this office.

Mean monthly discharges at Rapide Croche, which corresponds closely to the discharges at Neenah and Menasha combined, for the year are as follows:

1900.	Cubic feet per minute.	1901.	Cubic feet per minute.
July	57,508	January	215,288
August	109,661	February	224,280
September	121,270	March	230,392
October	818,782	April	537,610
November	483,665	May	800,044
December	264,246	June	228,081
		Mean for year	256,781

This is by far the highest mean daily discharge on record; the normal discharge has been assumed at 170,000 cubic feet per minute, but the highest reached, previous to the past year, since measurements have been taken daily at Rapide Croche in 1896 was 162,507 cubic feet per minute in 1899. This means an increase in the value of the water for the past year of 51 per cent above the normal.

High water on the Wisconsin River occurred at Portage City on October 9, 1900, gauge reading + 12.5′, and was the highest water on record. At the previous flood, April 24, 1900, the gauge read + 11.6′. No damage was done to Government works during the October flood, but they were in imminent danger and required much vigilance. The Caledonia and Barden levees (private works on the right side of the river) gave way, letting out the water and undoubtedly saving the Government works to a large extent.

Flushboards were placed on the Menasha dam by the Neenah and Menasha Water Power Company, May 29, 1900, and were removed October 5 and 6, 1900. They were replaced December 14, 1900, and again removed February 25, 1901. * * * The boards were again replaced June 10, 1901, removed June 12, replaced June 14, again removed on the 17th, and again replaced on the 24th, when water was 8 inches above the crest and falling. Sluicing in both the Neenah and Menasha dams was carried on to keep the water down in Lake Winnebago from October 19 to December 1, 1900, and again from April 6, 1901, to May 2, 1901, * * * and the spring flood, which undoubtedly was the largest in volume for time of flow on record, was regulated with the best of satisfaction and without damages worth mentioning above or below Menasha dam. The water in Lake Winnebago was not permitted to rise higher than 17 inches above the crest. The duration of sluicing this spring was 26 days, and the mean discharge during that period was 582,282 cubic feet per minute.

Gauge readings were calculated, tabulated, and platted, as were also daily discharges of the river at different points.

REPAIRS OF LOCKS, ETC.

Depere dam.—The bulkhead at sixth sluiceway at left end of dam, where private wing dam abuts the Government dam, being badly decayed, was built above the water surface with rough dimension stone, laid in cement mortar. This work was completed June 20, 1901.

Rapide Croche lock.—The lower wing cribs being decayed were rebuilt above water surface with 6,864 feet B. M. of pine timber. The stone which had caved into canal from upper right wing wall was removed by Dredge No. 5; repairs to lock completed June 27,1901.

Rapide Croche dam.—This dam was backed with 1,020 cubic yards of clay which was taken from the bank near the entrance to canal, loaded on scows, and placed by hired labor. Fourteen cords of rubblestone was purchased at Kaukauna, transported by scow, and placed for riprap above sluiceway to prevent washing.

CONSTRUCTION OF KAUKAUNA DRY DOCK AND SHOPS.

Dry dock.—This work was practically completed during the last fiscal year. (See Annual Report, Appendix L L, page 3725.) Thirteen hundred and twenty-eight cubic yards of earth was excavated from the basin and placed for filling at the lower end; the left bank was riprapped with 6 cords of stone excavated from the basin; capstans, spars, etc., on hand were placed for operating the head gates, completing the dry dock proper on September 10, 1900.

Fence.—A woven-wire fence 50 inches high and 770 feet long was built around the property upon which the dry dock is situated and was completed November 10, 1900.

Blacksmith shop.—A blacksmith shop 20 feet wide and 36 feet long was built. * * * A drill press, lathe, forge, blower, etc., were purchased and set up. The building was completed September 29, 1900.

Timber shed.—A timber shed 24 feet by 48 feet was erected.

* * * * * * *

The buildings and fence were painted one coat of drab paint in October, 1900.

The dry dock is a decided success, and has already been used in docking two dredges and two dump scows and has saved considerable of its cost of construction. It is very simple and economical in its manipulation, two dredges were docked ready for making repairs by four men in less than three hours. The stationary docking is high enough so that a boat need not be raised after once placed.

Kaukauna locks.—Fender planks on gates of Kaukauna locks where defective were replaced with new material.

Kaukauna dam.—The decayed timber in trestle and walk to sluiceway was removed and replaced with new material.

* * * * * * *

Repairs completed April 5, 1901.

Little Chute combined locks waste weir.—The right wall of this weir being badly damaged by frost, the defective part of wall was removed and a concrete floor was laid, extending underneath the right wall and for a distance of 30 feet below the apron. The right wall was rebuilt with cement masonry, and the upper end of side walls were rebuilt with dry rubble masonry.

* * * * * * *

The repairs were completed, with the exception of pointing the walls, in December, 1900. The walls were pointed in June, 1901.

Little Chute combined locks.—The joints in the walls of these locks were raked out and partly repointed with Portland cement mortar.

* * * * * * *

Little Chute second lock canal banks.—The dry retaining wall on right bank of canal, immediately below this lock for a distance of 128 feet, was rebuilt to a height of 10 feet and a thickness of 2½ feet, using old material for this purpose; repairs completed December 20, 1900.

Little Chute second lock head wall.—The archway in the head wall of this lock, formerly closed with timber and earth, was permanently closed with cement masonry and backed with clay. The timber and earth was removed from above the archway, completing the repairs December 20, 1900, with the exception of pointing, which was completed June 10, 1901.

Little Chute second lock.—The joints in walls of this lock were raked out and repointed with Portland cement mortar; repairs completed June 13, 1901.

Repairs to Appleton fourth lock house.—Two hundred and five East Lake tin shingles and 15 starters for same were used in covering the roof of rear part of this house, the work being completed November 19, 1900.

Repairs of crib wall below Appleton third lock.—This wall, extending from the third lock to center pier of railroad bridge below, consists of timber cribs filled with stone. The decayed superstructure was removed and rebuilt, * * * completing the work on October 3, 1900.

Rebuilding Appleton second lock.—This lock was originally built by the Fox and Wisconsin River Improvement Company about 1858, and was entirely rebuilt by the United States in 1878. The walls were composed of concrete, faced with cut stone, and backed partly with rubble masonry. The cut stone was laid in courses from 8 to 10 inches in thickness, with beds alternating only 14 and 10 inches wide. The facing stone being insufficiently bonded to the concrete, had become separated, and water getting behind the facing had, under pressure from above the lock, forced the same out of place. In 1887 and 1896 repairs were made, putting in tie-rods with large iron-plate washers. Automatic iron valves also were placed to relieve the pressure of water when lock was empty. This assisted in maintaining the lock for some years, but the walls continued to become weaker, and threatening to fall in, it was necessary to rebuild them. The present repairs consisted in rebuilding the side walls with rubble masonry, faced with heavy wide and narrow bed cut stone; rebuilding the upper and lower wing walls with cement masonry; rebuilding valve platform; new valve system; rebuilding lower and upper gates; providing new maneuvering gear, steel gate spars, etc. The dimensions and position of lock remain unchanged.

Construction.—Work was commenced November 14, 1900. Stop timbers were placed at the head of Appleton first lock and the water was drawn off the canal. Earthen dikes were thrown up both above and below the lock. The work of rebuilding was carried on in the same manner as the rebuilding of Appleton third lock during the last fiscal year (see annual report, Appendix L L, page 3726), with the following exceptions: A spur track was built by the Chicago, Milwaukee and St. Paul Railway Company along the left side of lock, at foot of canal bank, upon which cars loaded with construction material were placed. A stiff-leg derrick, operated by a hoisting engine, was placed on canal bank midway between side track and lock wall. A tram trestle was erected from old timbers through lock chamber. Stone received by cars was transferred to tram cars with the stiff-leg derrick and placed in position from the tram cars with the four guy derricks erected on the center line of the lock. The pumping was operated but about fifteen minutes daily, in order to keep the lock pit dry.

Masonry.—The old walls were entirely removed to a height of about 6½ feet above lock floor, and below that point the face stone and concrete backing were removed for a width of about 4 feet. The concrete backing was found to be of very poor quality and in places entirely disintegrated, and could be shoveled out. Little blasting was required to loosen up the concrete for its removal. After all the concrete was removed and exposed to the weather most of it disintegrated and fell to pieces. The surface was then cleaned and leveled off even with the bottom of lower miter sill with concrete for foundation of new wall. Cut stone 19½ inches in thickness was purchased from L. Lindauer, of Kaukauna, Wis., and laid in the face of the first, fourth, seventh, tenth, thirteenth, and sixteenth courses, the first and fourth courses being 4 feet width of bed, the balance being 2 feet 8 inches bed. The intermediate courses were faced with narrow bed cut stone, selected from the old face stone of the lock, with the exception of four quoin stones, four recess corner stones, and the upper recess and head-wall stones in the seventeenth and eighteenth courses, which were cut from derrick rubble 17½ inches in thickness. The backing was laid up with derrick rubble purchased and rubble stone removed from the old walls. The old coping was used, with the exception of one quoin stone, which was broken and had to be replaced. The walls are 8 feet wide on the bottom and 4 feet 6 inches wide on top. T-walls 3½ feet wide and 5 feet long were built of concrete and rubble masonry back of the head walls on either side, for the purpose of strengthening the head walls and to prevent leakage around the head of the lock. All masonry was laid with Utica cement mortar and the face work was pointed with Portland cement.

Valve platform.—The valve platform was rebuilt in the same manner as at Appleton third lock; above referred to, and provided with modern butterfly valves operated by gearing on the lock walls, the old chain and lever apparatus being defective, and obsolete. The center pier supporting the platform, being defective and improperly placed, was rebuilt; additional supports of double extra strong gas-pipe stanchions, 3½ inches outside diameter, were also provided.

Lock gates.—The lower gates were rebuilt of solid timber from the paddle arms up. The upper gates were refitted and repaired. Steel gate spars were provided for the gates in place of the wooden spars, the necessary changes being made in tripods. The spars for the lower gates, instead of being attached at the outer end near the toe, are attached near the middle of the gate; the length of spar is reduced from 28 feet 8 inches to 22 feet. It was found impracticable to make this change at the upper gates on account of the position of the maneuvering gear for platform valves. The wooden hand rails on gates were replaced with gas-pipe hand rails. All timber used in the work was of Oregon fir. The plant used in rebuilding this lock was all on hand, the only additional material required being steel-wire rope for guys to derricks. Water was let into the lock on April 29. The lock was completed and grading finished May 15, 1901. The following is a summary of quantities:

Earth placed and removed for cofferdams	cubic yards..	575
Earth excavated for new construction	do....	2,228
Old timber removed	feet B. M..	30,445
Rubble masonry removed	cubic yards..	551
Concrete removed	do....	1,480
Dry rubble removed from wing cribs	cords..	33
Cut stone laid in walls, wide bed	cubic feet..	11,964
Cut stone laid in walls, narrow bed	do....	4,204
Rubble masonry laid in walls	cubic yards..	1,580
Rubble masonry laid in wing walls	do....	256
Crushed stone used for concrete	do....	331
Sand used	do....	418
Natural cement (Utica) used	barrels..	1,452
Portland cement (Alsen) used for pointing	do....	10
Fir timber used in platform gates, sills, etc	feet B. M..	23,084
Iron, steel, and castings used	pounds..	23,564
Filling and grading	cubic yards..	2,335

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Appleton revetment wall.—Through the action of the frost the coping and upper courses of this wall had become displaced, requiring repairs. Work was commenced on September 22, 1900. Two flat scows were lashed together, upon which were placed the stiff-leg derrick and hoisting engine, cement shed, etc. The coping and face stone and rubble backing were removed, cleaned, and relaid in cement mortar as follows, beginning at the upper end:

Coping, 3 courses of face stone and backing	linear feet..	333
Coping, 2 courses of face stone and backing	do....	132.2
Coping, 1 course of face stone and backing	do....	84.8
Coping only to lower end	do....	285.4

The joints in face above water and in the rear and top were raked out and pointed with cement mortar; the old wall timbers in front of revetment wall were removed to water surface, the stone leveled off and covered with clay. Repairs completed October 27, 1901.

Remarks.—Total length of wall repaired is 835.4 linear feet (length of wall). The mortar used in repairing the upper courses of this wall the previous time was a mixture of lime and cement, and evidently of a poor quality, as it readily washed out, allowing the water to get into the joints and ice to form, which displaced the stones, in some places over 1 foot. The mortar used in the above-mentioned repairs was pure Louisville cement, and the joints were pointed with "Atlas" Portland cement. The wall is now in excellent condition.

Appleton upper dam.—This dam was backed with 1,800 cubic yards of clay removed from bank above Appleton first lock.

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Repairs completed October 13, 1900.

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Menasha lock house.—A storm shed 4 by 8 feet was built on porch at the west or rear door, the porch being enlarged for that purpose. Six storm sash were purchased and fitted to windows on north and west sides of house. Repairs completed November 16, 1900.

Menasha channel cribs.—Four cribs marking the channel through the rock in Menasha River were rebuilt above water surface. The upper right crib, being constructed of plank, was not considered substantial. A new crib was therefore built and sunk immediately above it. The cribs were filled with stone and planked over and provided with posts 12 feet high painted white.

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Repairs completed October 3, 1900.

Berlin lock house and shops.—*Lock house.*—The woodwork in six rooms and two halls was painted one coat of white paint; the balusters to stairway were varnished; the walls and ceilings of five rooms and two halls were papered by agreement. Repairs completed May 31, 1901.

Repair shop.—The roof was reshingled with cedar shingles; collar pieces of 2 inches by 6 inches by 16 feet were placed to strengthen roof; the floor was leveled up and strengthened with blocking. Repairs completed November 9, 1900.

Iron shed.—The roof boards were relaid and the roof shingled with cedar shingles and finished with ridge boards and fascia. Repairs completed November 10, 1900.

Berlin lock.—Slight repairs were made to the gates, and the tripods were leveled up, completing repairs on November 6, 1900.

Grand River dam.—The shore protection below left abutment, being undermined, was raised with 200 brush mats and covered with 21 cords of rubble stone; 20 cubic yards of earth was filled in back of the abutments, completing the repairs November 2, 1900.

Grand River lock.—The tripod platforms were leveled up with 14 cubic yards of clay and gravel, completing the repairs October 25, 1900.

Montello dam.—The bank immediately below the left abutment for a distance of 160 linear feet was riprapped with 27 cords of rubble stone, completing repairs November 1, 1900.

Montello lock.—The upper-wing cribs were removed to water surface and rebuilt with 4,986 feet B. M. of old timber removed from Fort Winnebago lock; the cribs were filled with 9.4 cords of stone and 38 cubic yards of sand; the gates were replanked above water surface with 660 feet B. M. of 2 by 12 inch pine plank; the tripod platforms were rebuilt with 682 feet B. M. of old timber from Fort Winnebago lock and filled with 10 cubic yards of clay and gravel. Repairs completed October 30, 1900.

Fort Winnebago lock.—Preparatory to making repairs to this lock (see annual report for fiscal year ending June 30, 1900, Appendix L L, page 3729) earthen dikes were thrown up both above and below the lock, the engine and pump were placed in position, and the lock was pumped out and examined. This lock was originally built in 1859, rebuilt by the United States in 1889 and 1890, and slightly repaired in 1898.

The lock walls from the lower quoin to the head wall, extending 8 feet below the upper hollow quoin, were built of dry rubble masonry faced with pine timber 8 inches square, secured to masonry with iron straps and bolts. These walls were about 7 feet thick and 14 feet high. The left wall was found in good condition with the exception of the first two courses of face timber, which was badly decayed. The face timber of right wall had fallen into lock chamber about half its length, carrying with it a large part of the wall. The hollow quoins and miter sills were badly decayed and repairs were necessary to the floor.

The immediate cause of the damage was the spring flood of 1900, the water from the Wisconsin River flowing into the Fox through the canal.

The present repairs consist in the renewal of the first two courses of face timber on left wall with old timber from right wall, rebuilding the defective part of the right wall with a framework of timber filled with dry rubble masonry, faced with a double sheathing of plank and tied to the rubble wall with iron tie-rods; new upper and lower right hollow quoins; new gate spars and repairs to miter sills, floor, gates, maneuvering gear for valves, etc.

Construction.—Derricks, tools, plank, fuel, etc., was loaded on scow at Berlin lock and with quarter boat was towed to the lock. The work of repairs was commenced July 25, 1900; the lock was pumped out, and the débris from the old right wall was removed. Three boom derricks held by guys and operated by hand were set up on center line of lock and were used to handle all material used in construction.

Miter sills.—A new floor or deck was laid under miter sills; new cheek pieces and king-posts of white oak, 10 inches by 16 inches by 20 feet, were placed to repair the same. The space between timbers in lower sills was filled with concrete.

Breast wall.—The coping timber was removed and replaced with timber taken from the old right wall and the masonry repaired.

Masonry.—T walls 4 feet thick, extending back into bank 10 feet, and 13 feet high, were built of concrete and cement masonry back of the head walls to strengthen the same and to prevent leakage around the head of the lock, which has long been a serious trouble. Quicksand was encountered in excavating for the T walls, and the trenches were inclosed in sheet piling, using old timber removed from lock. The face of both walls at upper and lower ends of lock was dressed by ball pointing and the joints were raked out and pointed with Portland cement. Louisville natural cement was used in the balance of the work.

Right wall.—Mudsills, posts, girts, etc., were framed and set up; new hollow quoin timbers of white oak were framed, placed, and bolted; the dry rubble walls were laid. During the construction of the latter tie-rods were placed and embedded in cement masonry; coping timbers were framed and placed and the walls faced with a double sheathing of plank.

Left wall.—The two top courses of timber on left wall was removed and replaced with old timber from right wall.

Gates.—The maneuvering gear for valves was repaired; new gate spars were framed and placed.

Miscellaneous.—The tripod timbers were replaced with old timbers from right wall, leveled up and filled with gravel; the floor was repaired where defective with pine plank; six snubbing posts were made and set, three on either side of lock; the derricks were taken down, the lock cleaned out, and the cofferdam below lock was opened and the lock allowed to fill, completing the repairs, with the exception of removing the cofferdams, on the 6th of October, 1900.

The plant used was loaded and transported to Berlin lock. On June 4 and 5, 1901, the cofferdams were removed by dredge No. 5, completing the repairs of this lock.

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Canal bank at wasteweir Fort Winnebago lock.—The canal bank where damaged by the flood in Wisconsin River on April 24, 1900, was repaired; 54 linear feet of revetment was straightened up; double sheet piling was driven back of same; revetment was anchored to posts set in bank with 6 1-inch tie-rods. The bank was filled with 576 cubic yards of earth; the bank at lower end of wasteweir was riprapped with 3 cords of stone, the wasteweir was decked over with 2-inch by 12-inch plank; repairs completed July 12, 1900.

Portage levee.—(See annual report for fiscal year ending June 30, 1900, Appendix L L, page 3729.) After the subsidence of the flood in Wisconsin River the two breaks were surveyed, and an agreement was entered into with Mr. J. D. Splaine to make the necessary repairs to same. The levee was repaired by filling with earth and sand, making top of bank 6 feet wide, with slopes of 1½ to 1. Twenty-two hundred and ninety-nine cubic yards of material was placed in the bank, and the outer slope of large break was riprapped with 13 cords of bowlders, completing the repairs to levee proper. The gap in river bank outside the large break was filled with 233 cubic yards of earth, upon which was placed 30 brush mats and 10½ cords of stone. Repairs completed September 13, 1900.

Portage lock.—The concrete filling on top of this lock was badly broken up and worn. The old concrete was removed, broken up, and the space was refilled to within 1½ inches of the top of timbers with new concrete made from Milwaukee cement and sand mixed with the old broken concrete. The top was covered with 1½ inches of cement mortar.

GENERAL REPAIRS TO LOCKS, DAMS, AND CANAL BANKS.

Little Kaukauna lock.—A rowboat 16 feet long 3 feet wide was built for use of lock tender.

Rapide Croche dam.—One hundred rock-elm needles 3 by 3 inches by 12 feet for use in closing sluiceway were purchased.

Kaukauna dry dock.—Four nail bins, each of about 100 pounds capacity, were built in blacksmith shop.

Kaukauna second lock.—The tripod platforms were rebuilt and leveled up, using old material on hand; gate spars were changed to pass over instead of under platform; spars were repaired.

Kaukauna first lock and house.—Gas-pipe spar rollers were provided in place of wooden rollers; one new gate spar was put in; blocks of fir timber were bolted to upper side of gate, to which were secured the gate spars, leaving top of gates clear for passage of lock tenders; other minor repairs were made. Five storm sash were purchased and fitted to windows on north and west sides of lock house.

Kaukauna locks.—The tripod platforms of first, third, fourth, and fifth locks were leveled up and given slight repairs.

Kaukauna lock houses.—The outside trimmings of houses at first, second, and fifth locks were painted one coat.

Kaukauna guard lock.—A broken tow-post band was repaired and one additional band was put on; some of the fender piles having been drawn by the ice, the fender timbers were removed, and three of the piles were driven, and one was drawn and redriven, by agreement; the fender timbers were replaced.

Little Chute combined locks.—The tripod platforms were repaired with old timber on hand.

Combined locks wasteweir.—Broken stone was placed and tamped at lower end of concrete floor, below apron, to prevent floor being undermined; the earth on sides of outlet was leveled off; clay was puddled in place to stop a leak above wasteweir; other minor repairs were made.

Little Chute second lock.—A new spar was placed on lower left gate.

Little Chute second lock-head wall.—A leak under stop timbers closing archway was stopped with shavings and manure, and bank was reinforced with clay. Archway has since been closed with cement masonry. (See repairs of Little Chute second lock-head wall.)

Little Chute first lock.—Gravel which had accumulated in upper recess was removed with hand dredge.

Cedars lock house.—A hard-wood floor was laid in dining roon.

Appleton upper and lower dams.—The anchor and truss rods in sluice gates were adjusted; the canal bank above sluice gate at lower dam was riprapped with 21 cords of rubble stone.

Appleton Canal.—One hundred and five cubic yards of clay was removed by hand from canal in the vicinity of South Division Street Bridge.

Menasha dam.—Leakages around sluice gates were stopped with two loads of manure placed around the gates.

Eureka lock and dam.—Slight repairs were made to sluice gates in dam and to lock gates.

Grand River lock house.—The walls and ceilings of three rooms were papered by agreement.

Governor Bend dam.—A foot bridge 3 feet 2 inches wide and 60 feet long was built across this dam to allow lock tender to reach lock.

Portage and Fort Winnebago locks.—In order to prevent damage being done to these locks during a flood which occurred on October 6, 1900, timber was temporarily placed on gates and alongside of lock walls and backed with earth; after subsidence of flood timber was removed.

Bulletin boards.—Bulletin boards for the display of notices at locks were purchased and placed at locks on Fox River; two at Appleton, Little Chute, and Kaukauna, and one at each of the other places.

Water gauges.—Enameled steel water gauges were placed at locks on upper and lower river.

DREDGING BARS AND CHANNELS.

Bars were removed from channel on Upper Fox River, as shown in tabulation below. The sand washed into Portage Canal by a flood during last fiscal year was partly removed; a channel is being cut from below Berlin dam to canal below lock; the canal between first and third locks at Appleton and between guard lock and third lock at Kaukauna were cleaned; the canal at Rapide Croche lock was cleaned of stone fallen in from the wing wall.

The following is a summary of the work done:

Summary of work done.

[See also tabulation of dredging.]

Between mileposts.	Length.	Summary of cuts.		Material (dipper measurement).		Character of material dredged.	No. of dredge working.
		Average width.	Average depth.	Handled.	Rehandled.		
	Feet.	*Feet.*	*Feet.*	*Cu. yds.*	*Cu. yds.*		
Kaukauna Canal	1,850	15–25	½–3	8,328	370	st. and c.	4 and 5
Appleton Canal	4,500	15–60	½–2	7,719	....	c. and st.	4 and 5
Menasha channel	3,270	20–60	1–2	8,572	....	c.	5
Berlin lock	1,420	30–50	1–10	14,620	277	s. and m.	4 and 5
48–49	200	60	1–2	780	....	s.	5
68–69	400	70	2–4	2,295	....	m.	5
69–70	1,180	70	1–4	8,253	....	m.	5
70–71	380	70	2–4	2,310	....	s. and c.	5
76–77	180	60	1–3	660	....	s.	5
Montello dam	....	....	....	50	....	g.	5
Fort Winnebago lock	....	....	....	525	....	s.	5
Portage	2,310	20–45	1–4	4,416	630	s. and m.	5
Total	....	....	....	53,528	1,277	....	....

NOTE.—"s." represents sand, "st." stone, "m." mud, "g." gravel, and "c." clay.

By authority of the honorable the Secretary of War, dredge No. 4, steam tug *Wolf*, and the side-dump scows Nos. 1 and 2 were loaned to Mr. John Stevens, of Neenah, Wis., for a period not to exceed 20 days. They were turned over to him on August 17 and returned in good order August 28, 1900.

Soundings, after dredging, were taken on Upper Fox River, from mile posts 33 to 34, 35 to 39, and from mile post 40 to White River lock; the channel was found to be in good condition.

CARE OF WORKS AND PROPERTY.

Coal for use of boats on inspection trips and in caring for property was purchased and distributed to points on upper and lower river.

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The hull of the old steam tug *Fox* was sold at auction on September 12 and was delivered to purchaser on November 1, 1900; the 90-foot scow sold at auction on same date was delivered to purchaser on date of sale, the old steam tug *Boscobel* was sold November 10 and delivered to purchaser November 20, 1900; repairs to Ames portable engine and boiler and hoisting engine at Appleton were made.

A watchman was employed at Berlin lock from November 17, 1900, to April 12, 1901, to assist lock tender in caring for boats, dredges, etc., laid up for the winter and for engineer property stored at warehouse.

SPECIAL REPAIRS TO DREDGING PLANT.

The hulls of dredges 4 and 5 required extensive repairs. They were placed in Kaukauna dry dock on September 11, 1900, and the work was commenced on both dredges on that date.

Dredge No. 4.—Repairs were made to gunwales, fender strake, plank-sheer, deck beams, decking, rake plank, and hatch coamings; the seams were hawsed, calked, and pitched.

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Dredge No. 5.—Repairs were made to spud guides, grub beams, knees, rake plank, plank-sheer, gunwales, and "A" frame sills; the seams were hawsed, calked, and pitched.

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The dredges were removed from dry dock on November 23 to allow the docking of de-dump scows Nos. 1 and 2. Repairs to dredges completed December 8, 1900.

Side-dump scows Nos. 1 and 2.—These scows were placed in dry dock on November 23, 1900, and given general repairs. Repairs were made to rake plank, gunwales, fender strake, docking, pocket partitions and linings, and timber heads; the general repairs were completed December 8, except calking, which was deferred till spring. Work was resumed on March 28 and the repairs were finally completed and scows removed from dry dock April 10, 1901.

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Dredge No. 7.—A new "A" frame for this dredge, the timber for which was purchased during the last fiscal year, was framed and raised; further repairs consisted in a new stern spud, strap on dipper blade, wearing piece in hawser pipe and shackle for guy to boom; repairs were completed October 3, 1900.

Two 80-foot scows.—Plans were prepared for two flat scows 80 feet long, 20 feet wide, and 4¾ feet deep, to be built of Oregon fir, each to be provided with two grousers and steps for two derricks.

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GENERAL REPAIRS TO PLANT, BOATS, DREDGES, MACHINERY, ETC.

Steam tug Wolf.—This boat was laid up at Berlin lock November 16, 1900. In April she was cleaned and painted and put in commission on the 25th and run to Appleton, where repairs were made to her machinery. The throttle valve was removed and repaired and the engine frame and bed was strengthened and other minor repairs were made.

Steam tug Fox.—This boat was laid up at Appleton first lock November 22, 1900. In April repairs were made to machinery and hull; a new and larger friction clutch was put on wheel shaft to replace broken one; a davit was put up for hoisting anchor. The gangways were changed in position and made wider. A new set of grates was furnished. The boat was cleaned and painted and put in commission May 10, 1901.

Dredge No. 2.—This dredge was laid up at Berlin lock August 15, 1900. In November material was purchased for two new forward spuds and in April material was purchased for a new dipper sheave casing, but as the dredge is not to be put in commission the repairs were not completed.

Dredge No. 4.—(See special repairs to dredging plant.) This dredge was laid up at Kaukauna dry dock September 13, 1900, for special repairs to hull; slight repairs were made to her machinery, and the hull, crane, and upper work were painted. She went into commission May 10, 1901.

Dredge No. 5.—(See special repairs to dredging plant.) This dredge was laid up at Kaukauna dry dock September 13, 1900, for special repairs to hull. Repairs were made to machinery, and grapple and slight repairs were made to wood scow and row boat. The outside of upper works are painted, and she was put into commission May 12, 1901.

SURVEY OF GOVERNMENT PROPERTY.

This work was commenced during last fiscal year. (See Annual Report, Appendix L L, page 2731.) The incompleted maps, eight in number, were finished, and 16 additional maps were drawn, making the set comprise 36 map sheets; a title page, the same size of maps, was drawn and tracings made of each of the 37 sheets. The descriptions of all lands owned by the United States or required for the use of the improvement were written and embodied in the final report of the work. A Coradi rolling planimeter was purchased, tested, and used for the computation of all irregular areas. The maps, tracings, and report were completed on the 11th of March, 1901.

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Respectfully submitted.

L. M. Mann,
Assistant Engineer.

Capt. James G. Warren,
Corps of Engineers, U. S. A.

Note.—Hydrograph [1] of Oshkosh Water Gauge, in separate roll, by mail—1 tracing and 1 blue print.

OPERATING AND CARE OF CANALS AND OTHER WORKS OF NAVIGATION, APPLIED TO FOX RIVER, WISCONSIN.

[Section 4 of river and harbor act of July 5, 1884.]

Detailed statement of expenditures for fiscal year ending June 30, 1901, with itemized statement of expenses attached as required by the above act of July 5, 1884.

Character of work, etc.	Item of expense.	Amount.	Total.
Repairs of Portage levee	Materials	$884.52	
Do	Labor	144.50	$1,029.02
Repairs of Portage lock	Materials	91.25	
Do	Labor	141.53	232.78
Repairs of waste weir, Fort Winnebago	Materials	28.72	
Do	Labor	191.67	220.39
Repairs of Fort Winnebago lock	Materials	1,745.00	
Do	Labor and transportation	2,701.55	4,446.55
Repairs of Montello dam	Materials	150.00	
Do	Labor	67.98	217.98
Repairs of Montello lock	Materials	29.33	
Do	Labor	131.09	160.42
Repairs of Grand River dam	Materials	100.00	
Do	Labor and transportation	194.33	294.33
Repairs of Grand River lock	Labor		10.16
Repairs of Berlin lock	do		30.83
Repairs of shops and lock house at Berlin lock	Materials	66.10	
Do	Labor	75.68	141.78
Repairs of Manasha channel cribs	Materials	126.86	
Do	Labor	122.08	248.94
Repairs of Menasha lock house	Materials	13.21	
Do	Labor	8.75	21.96
Repairs of Appleton revetment wall	Materials	427.88	
Do	Labor and transportation	1,882.01	2,309.89

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[1] Not printed.

Detailed statement of expenditures for fiscal year ending June 30, 1901, etc.—Continued.

Character of work, etc.	Item of expense.	Amount.	Total.
Repairs of Appleton upper dam	Labor		$572.87
Rebuilding Appleton second lock	Materials	$9,840.56	
Do	Labor and transportation	13,098.98	
			22,939.54
Repairs of crib wall below Appleton third lock	Materials	101.86	
Do	Labor	88.12	
			189.98
Repairs of Appleton fourth lock house	Materials	29.77	
Do	Labor	6.25	
			36.02
Repairs of head wall, Little Chute second lock	Materials	156.25	
Do	Labor	332.42	
			488.67
Repairs of canal banks below Little Chute, second lock.	Labor and transportation		234.25
Repairs of Little Chute second lock	Materials	7.80	
Do	Labor	48.00	
			55.80
Repairs of Little Chute combined locks	Materials		13.00
Repairs of waste weir at Little Chute combined locks.	do	145.00	
Do	Labor and transportation	589.75	
			734.75
Repairs of Kaukauna dam	Materials	38.32	
Do	Labor	49.30	
			87.62
Repairs of Kaukauna locks	Materials		28.24
Construction of Kaukauna dry dock	do	779.49	
Do	Labor	1,171.78	
			1,951.27
Repairs of Rapide Croche lock	Materials		210.07
Repairs of Rapide Croche dam	do		34.15
Repairs of De Pere dam	do		27.50
Lighting lock, Lower Fox	Oil		12.54
Survey of boundaries of Government property	Labor		2,118.65
Dredging bars and channels	Fuel, supplies, etc	714.59	
Do	Labor	1,741.33	
			2,455.92
Repairs of plant, boats, dredges, etc	Repairs of tug Wolf	399.91	
Do	Repairs of tug Fox	853.19	
Do	Repairs of dredge No. 2	249.29	
Do	Repairs of dredge No. 4	420.09	
Do	Repairs of dredge No. 5	713.31	
Do	Repairs of dredge No. 7	107.95	
Do	Materials	127.66	
Do	Labor	213.91	
Do	Miscellaneous	123.24	
			3,208,55
Special repairs of dredging plant	Repairs of dredge No. 4	1,412.28	
Do	Repairs of dredge No. 5	1,276.23	
Do	Repairs of dredge No. 7	271.25	
Do	Repairs of side dump scow No. 1	269.51	
Do	Repairs of side dump scow No. 2	256.18	
Do	Repairs of 80-foot flat scow	47.92	
Do	Labor	56.92	
			3,590.24
General repairs of locks, dams and canal banks	Materials	1,867.25	
Do	Labor and transportation	1,447.19	
			3,314.44
Care of works and property	Watchmen, labor and transportation	2,016.93	
Do	Traveling expenses of assistant engineers, overseers, etc	221.10	
			2,238.03
Maintenance of navigation	Lock tenders' services	7,015.00	
Do	Messenger and gauge keepers' services	513.33	
Do	Overseers, laborers, etc	679.73	
			8,208.06
Contingencies	Salaries of assistant engineers, clerks, etc	3,695.00	
Do	Rent of office, Oshkosh	300.00	
Do	Rent of telephones and tolls	190.37	
Do	Mileage of officers	89.21	
Do	Rent of P. O. box	3.00	
Do	Telegrams	1.58	
Do	Job printing	57.75	
Do	Stationery	66.16	
Do	Envelopes	34.64	
			4,437.71
Total			66,552.85

L L 22.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

Removal of wreck of stone scow from Sturgeon Bay and Lake Michigan Ship Canal, Wisconsin.—On the evening of November 20, 1900, a flat scow, with a cargo of about 150 cords of stone, sunk in Sturgeon Bay and Lake Michigan Ship Canal, about 300 feet from the easterly end of the canal.

The scow, which was owned by the George Pankratz Lumber Company, of Sturgeon Bay, Wis., was in tow of the tug *Duncan City* and hardly reached the easterly end of the canal when another tug coming in from Lake Michigan compelled the master of the *Duncan City* to slightly change its course. A strong current was running through the canal from Sturgeon Bay to Lake Michigan—the tug and scow moving in the same direction. While changing the course one tow line parted, and the current caused the scow to sheer to the northerly side of the canal, where it collided with the revetment; the current then swung the stern of the scow until it collided with the south revetment.

The force of the collision so seriously damaged the scow that it sunk in a few minutes. The scow was 150 feet long, 10 feet deep, and carried a deck cargo about 5 feet high. Where the accident occurred the canal is but 130 feet wide, so that the sinking of the scow completely blocked the channel, rendering immediate measures for the removal of the obstruction imperative.

Under authority of section 20 river and harbor act, approved March 3, 1899, the United States assumed control of the wreck and operations for its removal were begun at once. On November 28 the obstruction had been sufficiently removed to permit the resumption of traffic through the canal, and on November 30 all obstructions were removed and the channel cleared.

No blame for the accident attaches to the master of the *Duncan City;* he had fully complied with all the canal regulations as to length and number of tow lines, speed, etc. The accident was due to parting of one of the tow lines, and to the strong current in the canal.

The cost of the removal of the wreck was $715.12, and paid from allotment made December 29, 1900, from the permanent indefinite appropriation made by section 20, river and harbor act of March 3, 1899.

L L 23.

EXAMINATION AND SURVEY OF STURGEON BAY AND LAKE MICHIGAN SHIP CANAL, WISCONSIN.

[Printed in House Doc. No. 117, Fifty-sixth Congress, second session.]

Office of the Chief of Engineers,
United States Army,
Washington, December 3, 1900.

Sir: I have the honor to submit herewith copies of reports by Capt. J. G. Warren, Corps of Engineers, dated June 28, 1900, and November 24, 1900, upon preliminary examination and survey, respectively, authorized by the emergency river and harbor act approved June 6, 1900, as follows:

Sturgeon Bay and Lake Michigan Ship Canal [Wisconsin]: With a view to deepening the Sturgeon Bay and Lake Michigan Ship Canal to eighteen feet; said improvement to begin at the Lake Michigan end of said waterway and to continue throughout the length of said canal and in the waters of Sturgeon Bay so far as is necessary to secure a navigable channel having a depth of eighteen feet of water from Lake Michigan to the waters of Green Bay.

By the terms of the act the object of the proposed improvement is to secure a navigable channel having a depth of 18 feet, which will require dredging to a depth of 21 feet below the datum of harbor improvement. The plan presented for obtaining the desired channel consists primarily of dredging from the 21-foot contour in Lake Michigan to the 21-foot contour in Sturgeon Bay, supplemented by rock removal and certain revetment work, and the cost of the entire project is estimated at $218,000. An alternate estimate is also submitted, which includes 1,000 feet of pier extension at the Lake Michigan entrance to the canal, but Captain Warren recommends that this latter plan be not adopted until the dredging plan shall have proved unsatisfactory.

In the opinion of the local officer, the proposed improvement of the canal and its connecting waters is justified by the present and prospective needs of commerce, and his views are fully concurred in by the division engineer, Col. J. W. Barlow, Corps of Engineers.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

Hon. ELIHU ROOT,
Secretary of War.

PRELIMINARY EXAMINATION OF STURGEON BAY AND LAKE MICHIGAN SHIP CANAL, WISCONSIN, WITH A VIEW TO DEEPENING THE SAME TO 18 FEET.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., June 28, 1900.

GENERAL: I have the honor to submit the following report upon a preliminary examination made in pursuance to instructions contained in letter, office of the Chief of Engineers, United States Army, dated June 13, 1900, and to comply with requirements of an item contained in section 2, river and harbor act, approved June 6, 1900, as follows:

> Sturgeon Bay and Lake Michigan Ship Canal: With a view to deepening the Sturgeon Bay and Lake Michigan Ship Canal to eighteen feet; said improvement to begin at the Lake Michigan end of said waterway and to continue throughout the length of said canal and in the waters of Sturgeon Bay so far as is necessary to secure a navigable channel having a depth of eighteen feet of water from Lake Michigan to the waters of Green Bay.

By act approved April 10, 1866, the United States granted to the State of Wisconsin 200,000 acres of land to aid in the construction of a breakwater and a harbor and ship canal, to connect the waters of Green Bay with the waters of Lake Michigan. This grant was accepted by the State of Wisconsin and turned over to the Sturgeon Bay and Lake Michigan Ship Canal and Harbor Company by act of the legislature of the State of Wisconsin, approved March 5, 1868.

On the 3d of March, 1873, the United States undertook the construction of what was termed a harbor of refuge at the entrance of the Sturgeon Bay Canal, which relieved the State of Wisconsin of a part of the work required by the original act. This harbor was completed in 1884, and a channel of navigable width, 17 feet deep below the plane of harbor improvements obtained, leading from Lake Michigan to the eastern entrance of the canal, at a cost to date for construction and maintenance of about $188,000.

The Canal Company from 1872 to 1881 constructed the canal, without locks or gates, 7,200 feet long, 100 feet wide at the water surface, and 15 feet deep below the plane of harbor improvements, and in continuation of the canal proper, dredged a channel in Sturgeon Bay 6,100 feet long, of about the same dimensions as the canal. Of the 14,400 linear feet of canal banks, 8,437 feet were provided with pile revetments.

April 25, 1893, the United States assumed possession of the canal by the payment of $81,833 to the canal company. Since then the canal has been increased in width to 130 feet for its entire length by offsetting the north revetment 30 feet, and rebuilding and extending the revetments upon the rectified line. For increasing its minimum width to 160 feet, the south revetment, by a similar offset, is in process of reconstruction, and at this date requires the rebuilding of about 3,000 feet to complete it.

Three thousand one hundred and forty vessels, carrying 1,417,112 net tons, passed through the canal during the calendar year ending December 31, 1899, being an increase of about 82 per cent since the United States took control of it in 1893.

In this connection I quote the conclusions of the Board of Engineers, dated December 3, 1886, printed in Annual Report of Chief of Engineers for 1887, pages 2021–2037, as to the importance of this work as a harbor of refuge, in which conclusions I fully concur:

> * * * Sturgeon Bay is the true harbor of refuge, and to make it available as such an ample basin should be excavated, the canal deepened, and works constructed in Lake Michigan exterior to the existing works of protection at the canal entrance. The conversion of Sturgeon Bay into a harbor of refuge accessible through the Sturgeon Bay Canal to all vessels which navigate the Great Lakes would add security to their shipping and may be regarded as a public necessity. * * *

The present depth of water is inadequate for the class of vessels that would make use of this waterway, as several of them were reported to have touched bottom while passing through during the past year. Menominee Harbor, Michigan and Wisconsin, is already provided with a depth of 20 feet below the datum plane, and a plan has been recommended, and now awaits the action of Congress, for deepening the channel of Green Bay Harbor to 20 feet. Vessels from these harbors bound for Chicago, Milwaukee, and other ports of Lake Michigan would naturally seek passage through the canal were there a sufficient depth of water for them to pass through in safety.

While this office now has soundings of recent date upon which an approximate estimate of the necessary dredging could be based, it is known that rock will be encountered at and near the eastern entrance to the canal, and it is possible that it may be found elsewhere; therefore a careful survey should be made to insure a reliable estimate.

If the survey could be begun on or before the 15th of July, an allotment of $1,000 from the act approved June 6, 1900, would be sufficient, as a plant owned by the Government now at Sturgeon Bay could be advantageously used for that purpose. If delayed much beyond that date, it is estimated that the sum of $1,500 would be required, as additional plant would have to be obtained, and the weather would cause delays that would materially increase its cost.

For the reasons stated herewith and the demands of commerce, present and prospective, I am of the opinion that the harbor and canal at Sturgeon Bay is worthy of improvement by the United States, and I therefore recommend that a survey be made.

Very respectfully, your obedient servant,

J. G. WARREN,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, NORTHWEST DIVISION,
New York, July 3, 1900.

Respectfully forwarded to the Chief of Engineers, United States Army, concurring in the views and recommendations of the district engineer.

J. W. BARLOW,
Colonel, Corps of Engineers,
Division Engineer.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
July 10, 1900.

Respectfully submitted to the Secretary of War.

Under the provisions of the emergency river and harbor act approved June 6, 1900, a preliminary examination has been made of the Sturgeon Bay and Lake Michigan Ship Canal, Wisconsin (full text of item quoted within).

For the reasons given the canal, which is the property of the United States, is reported to be worthy of enlargement to meet the demands of the present and prospective commerce, and I recommend that a survey be made and the cost of improvement be estimated.

A. MACKENZIE,
Acting Chief of Engineers.

[Third indorsement.]

WAR DEPARTMENT,
July 11, 1900.

Approved as recommended by the Acting Chief of Engineers.

ELIHU ROOT,
Secretary of War.

SURVEY OF STURGEON BAY AND LAKE MICHIGAN SHIP CANAL, WISCONSIN, WITH A VIEW TO DEEPENING THE SAME TO 18 FEET.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., November 24, 1900.

GENERAL: I have the honor to submit the following report upon the survey of the Sturgeon Bay and Lake Michigan Ship Canal, made in compliance with an item contained in section 2 of the act of Congress approved June 6, 1900, "making provision for emergencies in river and harbor works for certain surveys, and for the diversion of certain appropriations or modification of provisions heretofore made," which reads as follows:

> Sturgeon Bay and Lake Michigan Ship Canal: With a view to deepening the Sturgeon Bay and Lake Michigan Ship Canal to eighteen feet; said improvement to begin at the Lake Michigan end of said waterway and to continue throughout the length of said canal and in the waters of Sturgeon Bay as far as is necessary to secure a navigable channel having a depth of eighteen feet of water from Lake Michigan to the waters of Green Bay.

The Sturgeon Bay and Lake Michigan Ship Canal is an important waterway connecting the waters of Lake Michigan with those of Green Bay, through an arm of the latter, known as Sturgeon Bay, the head of which, in its natural condition, was separated from Lake Michigan by a narrow neck of land about $1\frac{3}{8}$ miles wide, having a maximum elevation above the lake level of about 28 feet. This canal was constructed during the years 1872 to 1881 by the Sturgeon Bay and Lake Michigan Ship Canal and Harbor Company, a corporation organized under the laws of the State of Wisconsin.

The purpose of this canal was to shorten the sailing distance from the southern part of Lake Michigan to Green Bay ports by from 50 to 75 miles, and to avoid the dangers of the natural passage known as "Death's Door," which lies between Washington Island and the northerly end of the peninsula separating Green Bay from Lake Michigan, and in which passage many disasters have occurred.

Complete histories of the canal and descriptions of the work done by the canal company are contained in the Annual Report of the Chief of Engineers for 1883, pages 1657–1678, and 1887, pages 2017–2037.

As constructed by the canal company, the canal was 7,200 feet long and 100 feet wide at the water surface, with a depth of 14 feet below the present datum plane of harbor improvements, the latter plane being 3.06 feet below the high-water mark of 1838, and identical with that to which soundings given on the lake survey charts are referred. The canal was without locks or gates, and of the 14,400 linear feet of canal banks, 8,437 linear feet were provided with pile revetments.

The act of July 13, 1892, appropriated $81,833 for the purchase of the canal by the Government, and on April 25, 1893, the United States took possession. The project for the improvement of the canal, adopted in 1894, provided for building about 6,000 linear feet of revetment, to complete the protection of the canal banks; the new revetments to be set back 30 feet on each side, thereby making the portion of the canal to be revetted 160 feet wide at the water surface; building 2,000 linear feet of fender piling; and dredging to obtain a depth of 15 feet below the datum plane of harbor improvements.

In 1896 the project was modified so as to provide for a width of 250 feet between revetments for the westerly 1,000 feet of the canal, and for the dredging and maintenance of a channel 200 feet wide and 15 feet deep below the datum plane of harbor improvements, from the westerly end of the canal to deep water in Sturgeon Bay. It also provides that whenever the old revetments built by the canal company are replaced, they shall also be set back 30 feet upon the line provided in the project of 1894, so as to give a width of 160 feet between them upon the main canal trunk.

The estimated cost of the original project and modification is

$113,500. (See Annual Reports of the Chief of Engineers for 1894, p. 2057, and for 1897, p. 2661.) Of this amount there has been appropriated $80,000, exclusive of purchase money, leaving a balance of $33,500 unappropriated under the present approved project.

At the present time the entire canal, with the exception of 351 linear feet at the westerly end, is provided with revetments, and a depth of 15 feet below datum is maintained. The north revetment has been entirely rebuilt, and work of rebuilding the south revetment is in progress; it is estimated that by the close of the present working season, the south revetment will be rebuilt on the new line with the exception of about 1,000 feet at the easterly end.

The so-called "harbor of refuge" at the easterly entrance to the canal really constitutes part of the canal. As a harbor of refuge it is valueless, but as an exterior work, affording a safe entrance to the canal in stormy weather, it is absolutely essential.

The original project for this harbor of refuge, adopted in 1873, provided for two converging piers inclosing a triangular area of about 10 acres. This project was modified in 1880, so as to increase the width of entrance from 235 to 335 feet, and the depth of channel to 17 feet below the present datum plane of harbor improvements. The piers were completed in 1884 and the dredging in 1886; since then the expenditures for the harbor of refuge have been for maintenance only.

As stated in Annual Report for 1900, the harbor of refuge and the canal form practically one work, and for the purposes of this report they will be so considered.

In compliance with the letter from the office of the Chief of Engineers, dated August 25, 1900, a survey of the canal and connecting channels, extending from deep water in Lake Michigan to deep water in Sturgeon Bay has been made. The results of this survey are embodied in the six maps[1] forwarded herewith, upon which the proposed channel has been laid down.

The act specifies "a navigable channel having a depth of eighteen feet of water." It has been assumed that a depth of 18 feet at the lowest stage of Lake Michigan is what is intended. From records of water levels kept at Milwaukee and at the canal, it appears that the water has a minimum stage of about 2½ feet below the datum plane of harbor improvements. In order, therefore, to secure a navigable depth of 18 feet at all times, a depth of at least 20½ feet below datum will be required. I have therefore made the estimates given herein for a channel having a depth of 21 feet below the datum plane of harbor improvements, and assume that to be the intent of the act.

The fact that the depth of channel at Menominee Harbor, Michigan and Wisconsin, has been increased to 20 feet, and that in compliance with section 22, river and harbor act of March 3, 1899, surveys have been made and reports submitted recommending a 20-foot channel in Menominee River and at Green Bay Harbor, Wisconsin, would seem to justify the foregoing assumption, as Menominee and Green Bay are the two most important harbors in Green Bay that would make use of the canal. Furthermore, it is assumed that the proposed channel is to be available for the largest vessels on the lakes; therefore the depth of the channel connecting lakes Erie and Huron should govern.

The plan proposed for obtaining this channel consists primarily of dredging from the 21-foot contour in Lake Michigan to the 21-foot contour in Sturgeon Bay.

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[1] Two of these maps were printed in House Doc. No. 117, Fifty-sixth Congress, second session; they are not reprinted.

It is proposed to dredge a channel 600 feet wide from the outer ends of the piers at the Lake Michigan end of the canal, as is shown by heavy broken red lines on map of harbor of refuge. It is believed that this channel can be maintained by dredging more cheaply than by extending the piers to the 21-foot contour. Experience had at Milwaukee Harbor, where a similar dredging plan was adopted, justifies the attempt at least of maintaining the unprotected channel.

It is believed that the currents passing through the canal will, by their scouring action, maintain the required depth of channel. The currents flow in both directions through the canal, but the prevailing current is from Sturgeon Bay to Lake Michigan. Currents having a velocity of 3 or 4 miles per hour are not uncommon, and their scouring action is plainly shown on sheet No. 1, map of head of Sturgeon Bay, accompanying this report, where, as indicated by the contours, steep banks have been maintained on each side of the artificial channel, with but little dredging.

Furthermore, the reef shown on map as lying about 600 feet southerly from the harbor entrance now serves to break the seas running from a southerly direction. Should the harbor piers be extended this benefit would be lost, and it might become necessary to build a breakwater in order to make entrance to the harbor and canal safe at all times.

But as experience may show that an unprotected channel can not be satisfactorily and economically maintained, an extension of each pier by 500 feet is shown on the map. It is recommended, however, that this latter plan be not adopted until the dredging plan shall have proved unsatisfactory.

From the outer ends of the piers to the westerly end of the canal it is proposed to dredge a channel of the required depth, the width of this channel varying from 297 feet at the entrance to 130 feet at the head of the canal proper. This latter width is to be maintained through the canal to a point 6,200 feet from its easterly end, from which latter point a channel 200 feet wide is to be dredged throughout the remainder (1,000 feet) of the canal and in Sturgeon Bay, as shown on maps of same by heavy, broken, red lines, until a natural depth of 21 feet is reached.

At the easterly end (lake entrance) of the canal, and in the harbor of refuge, rock will be encountered on the south side of canal and channel. A careful examination was made of this rock by means of a water jet, and its depth below datum determined, and from data thus obtained the estimate of the quantity to be removed has been prepared.

In laying down the lines of the proposed channel, some changes have been made in the courses of the present channel. As shown upon Sheet No. 1, map of head of Sturgeon Bay, the present channel is not precisely in line with the canal. It is proposed that the new channel shall be dredged in direct line with the canal. The present channel makes an angle in the drawbridge at the city of Sturgeon Bay. It is proposed to omit this angle, and lay a straight course through the bridge. This will necessitate a change in the drawbridge; but the present structure has already been complained of as affording an opening of insufficient width for the passage of vessels now using the waterway. With vessels of greater draft and beam, using the canal and connecting channels, the present draw will certainly be insufficient and a clear width of not less than 100 feet will be required. As this will require an extensive remodeling of the existing structure, it is thought best to so fix the channel that no turn will have to be made in the draw.

It is also proposed to increase the width of channel at the angles in same, so as to afford additional room for large vessels when changing course.

The estimated cost of the proposed improvement is as follows:

Completion of present project	$33,500
Removing 3,000 cubic yards rock, at $5 per yard	15,000
Dredging 1,500,000 cubic yards, at 10 cents	150,000
Contingencies	19,500
	218,000

The foregoing estimate makes no provision for extending the harbor piers, as for reasons already stated it is thought best to defer such extension until the necessity therefor shall be more fully demonstrated. Should such extension become necessary, it is proposed to extend each pier 500 feet, by 5 timber cribs, each 100 feet by 24 feet, sunk on a pile foundation, filled with stone and riprapped, and provided with a permanent concrete superstructure. The total estimate for the proposed improvement would then be as follows:

Completion of present project	$33,500
Removing 3,000 cubic yards rock, at $5 per yard	15,000
Dredging 1,500,000 cubic yards, at 10 cents	150,000
1,000 linear feet pier extension, at $100 per foot	100,000
Contingencies	29,500
	328,000

The commercial importance of this waterway has been fully established, and since the purchase of the canal by the United States, and the abolishment of tolls, the tonnage passing through the canal has greatly increased. The following table shows the number of vessels and tonnage passing through the canal for eight years from 1892 to 1899, both inclusive:

Arrivals and departures of vessels.

Year.	Steam.		Sail.		Unrigged.[1]		Total.		Increase since 1892.
	Number.	Net tons.	Number.	Net tons.	Number.	Net tons.	Number.	Net tons.	
									Per cent.
1892	1,875	403,125	2,280	490,200	....	....	4,155	893,325	....
1893	1,953	593,926	1,965	402,839	232	40,973	4,150	1,037,738	16.17
1894	2,036	807,924	2,026	399,539	140	32,118	4,202	1,239,581	38.76
1895	2,102	822,757	1,558	315,340	289	166,318	3,949	1,304,415	46.02
1896	2,063	813,611	1,482	269,112	486	475,425	4,031	1,558,148	74.42
1897	2,128	722,165	1,552	297,755	734	666,061	4,414	1,685,981	88.73
1898	2,062	653,540	1,254	194,987	459	437,358	3,775	1,285,885	43.94
1899	1,994	748,294	1,363	258,670	483	410,148	3,840	1,417,112	58.63

[1] Car ferry barges, stone scows, and similar craft.

During 1892 the canal was owned and operated by the canal company, and tolls were charged. Since then tolls have been abolished and the canal has been deepened to 15 feet and widened.

A large number of vessels annually make use of the canal to seek shelter from severe storms in the quiet waters of Sturgeon Bay. Full statistics of the number and class of vessels making such use of the canal are given in the Annual Reports of the Chief of Engineers under the report on improvement of Sturgeon Bay and Lake Michigan Ship Canal.

The present depth of 15 feet in the canal does not permit the largest class of vessels to use Sturgeon Bay as a harbor of refuge, and even those craft whose draft is such as to allow them to pass through the canal are compelled to pass some distance down the bay before reaching anchorage ground. Should the canal and connecting channels be deepened to 21 feet, the largest vessels seeking shelter in Sturgeon Bay would be compelled to go below the bridge in order to reach anchorage ground. It may therefore become advisable and necessary, in the interests of general navigation, at some future time to dredge an artificial basin near the head of Sturgeon Bay to provide anchorage ground for the largest vessels seeking shelter.

In this connection attention is especially invited to fourth, fifth, and sixth conclusions of the Board of Engineer Officers, published in Annual Report of the Chief of Engineers for 1887, Part 3, page 2036.

The canal and connecting channels are considered worthy of the proposed improvement, which is, in my opinion, justified by the needs of present and prospective commerce.

Very respectfully, your obedient servant,

J. G. WARREN,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, NORTHWEST DIVISION,
New York, November 26, 1900.

Respectfully forwarded to the Chief of Engineers, United States Army.

I concur fully in the opinion of the district engineer that "the canal and connecting channels are worthy of the proposed improvement," and recommend that the project receive favorable consideration.

J. W. BARLOW,
Colonel, Corps of Engineers,
Division Engineer.

L L 24.

PRELIMINARY EXAMINATION OF MANITOWOC HARBOR, WITH A VIEW OF MAKING A HARBOR OF REFUGE WITH A DEPTH OF NOT LESS THAN 20 FEET.

[Printed in House Doc. No. 95, Fifty-sixth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, November 20, 1900.

SIR: I have the honor to submit herewith for transmission to Congress report, dated June 23, 1900, by Capt. J. G. Warren, Corps of

Engineers, upon preliminary examination of Manitowoc Harbor, Wisconsin, "with a view of making a harbor of refuge with a depth of not less than 20 feet," authorized by the emergency river and harbor act approved June 6, 1900.

Very respectfully, your obedient servant,

John M. Wilson,
Brig. Gen., Chief of Engineers,
U. S. Army.

Hon. Elihu Root,
Secretary of War.

REPORT OF CAPT. J. G. WARREN, CORPS OF ENGINEERS.

United States Engineer Office,
Milwaukee, Wis., June 23, 1900.

General: I have the honor to submit the following report upon a preliminary examination, made in pursuance to instructions contained in letter, Office of the Chief of Engineers, United States Army, dated June 13, 1900, and to comply with requirement of item contained in section 2, river and harbor act approved June 6, 1900, as follows:

> Manitowoc Harbor: With a view of making a harbor of refuge with a depth of not less than twenty feet.

The improvement of this harbor was begun by private enterprise in the summer of 1843, a small party of men, with a yoke of oxen and the use of a scraper, being employed for the purpose of opening a channel 2½ feet deep across the bar, at the mouth of the river, to admit the passage of the schooner *Soloman Juneau* from the river to Lake Michigan. The object sought was accomplished in three days.

The original project adopted in 1852 provided for the construction of parallel piers and dredging between them for the formation of a channel 12 feet deep. In accordance with subsequent modifications the channel has been increased in depth to 20 feet, and a breakwater 400 feet long, built in 1895, to afford protection from northeasterly storms; its outer end is 500 feet east of the north pierhead. The required depth of channel was obtained in 1898. In order to obtain the 20-foot channel the south pier was extended 500 feet in 1897, bringing its outer end just abreast of the southeasterly end of the breakwater. It is said by parties interested in navigation that the breakwater served well the purpose for which it was designed until the south pier extension was completed. Since then the northeasterly seas have a free passage into the harbor, and consequently the object for which the breakwater was built is defeated.

An item in the river and harbor act approved March 3, 1899, provided for a survey with plan and estimate of cost of works required to remedy this difficulty, and under date of December 12, 1899, a report[1] was submitted recommending that the breakwater be extended in an easterly direction for a distance of 400 feet on a line parallel with the south pier extension, and about 295 feet distant therefrom, at an estimated cost of $37,000. This plan was approved by the division engineer, and by the Chief of Engineers, and now awaits the action of Congress.

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[1] Printed in House Doc. No. 233, Fifty-sixth Congress, first session, and also in Annual Report of the Chief of Engineers for 1900, page 3761.

Manitowoc is situated at the mouth of the Manitowoc River, on the west shore of Lake Michigan and about 77 miles north of Milwaukee. Its population in 1895 was 9,427. It is the terminus of a division of the Wisconsin Central Railway, and an important station on one of the divisions of the Chicago and Northwestern Railway. It is thus provided with rail transportation to west, north, and south. Both the Flint and Pere Marquette Railway Company and the Ann Arbor Railroad Company operate car-ferry lines between Manitowoc and ports on the eastern shore of Lake Michigan, and the Goodrich Transportation Company operates a daily line of steamers to ports on the western shore of Lake Michigan and in Green Bay. Manitowoc is also a port of call for steamers of the Lehigh Valley Transportation Company and the Erie and Western Transportation Company that ply between Chicago and Buffalo.

The general commerce of the lakes is benefited by the facilities that this harbor affords. During storms its shelter is sought by many masters of vessels, and unseaworthy craft are also brought here for repairs at the shipyard and dry dock.

The principal exports by way of the harbor are grain and flour, and the principal imports are coal and coke.

Manitowoc is already provided with a channel 295 feet wide at entrance, 20 feet in depth, protected by substantial piers, and a breakwater 400 feet long. A plan has also been submitted for its extension 400 feet that is approved by the Engineer Department, with a recommendation that an appropriation of $37,000 be made by Congress for its construction. When this is accomplished, and the local authorities complete the dredging that is now in progress for the purpose of extending the 20-foot channel up the river, it is believed that the harbor of Manitowoc will afford ample refuge for the local and general commerce that will be likely to seek its shelter from storms, and for the foregoing reasons the improvement of the locality by the General Government in the manner contemplated by the act of June 6, 1900, is not advisable.

Very respectfully, your obedient servant,

J. G. WARREN,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, NORTHWEST DIVISION,
New York, June 25, 1900.

Respectfully forwarded to the Chief of Engineers, United States Army, concurring in the opinion of the district engineer, that the further improvement of the locality by the General Government in the manner contemplated by the act of June 6, 1900, is not advisable.

J. W. BARLOW,
Colonel, Corps of Engineers,
Division Engineer.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
November 1, 1900.

Respectfully submitted to the Secretary of War concurring in the opinion of the local officer and of the division engineer that improvement of the locality by the General Government in the manner contemplated by the act of June 6, 1900, is not advisable.

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

[Third indorsement.]

WAR DEPARTMENT,
November 2, 1900.

The views of the local officer and of the division engineer, as concurred in by the Chief of Engineers, are approved.

ELIHU ROOT,
Secretary of War

L L 25.

PRELIMINARY EXAMINATION OF MILWAUKEE HARBOR, WISCONSIN, WITH A VIEW TO NECESSARY ENLARGEMENT AND SUITABLE PROTECTION THEREFOR.

[Printed in House Doc. No. 86, Fifty-sixth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, November 21, 1900.

SIR: I have the honor to submit herewith, for transmission to Congress, copy of report dated August 6, 1900, by Capt. J. G. Warren, Corps of Engineers, upon preliminary examination of Milwaukee Harbor, Wisconsin, "with a view to necessary enlargement and suitable protection therefor," authorized by the emergency river and harbor act approved June 6, 1900.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

Hon. ELIHU ROOT,
Secretary of War.

REPORT OF CAPT. J. G. WARREN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., August 6, 1900.

GENERAL: I have the honor to submit the following report upon a preliminary examination made at Milwaukee Harbor, Wisconsin, in pursuance of instructions contained in letter from Office of the Chief of Engineers, United States Army, dated June 13, 1900, and to comply with requirements of an item in section 2 of act approved June 6, 1900, which reads as follows:

> Milwaukee Harbor: With a view to necessary enlargement and suitable protection therefor.

The harbor of Milwaukee is situated on the western shore of Lake Michigan, about 100 miles north from the head of the lake. The present harbor entrance is about 3,000 feet north of the original mouth of the Milwaukee River. Two small streams—the Menominee and Kinnickinnic rivers—empty into the Milwaukee River a short distance from the harbor entrance. Milwaukee Bay is formed by an indentation of the coast line, about 2 miles deep, and 7½ miles between headlands. In its natural condition the original entrance to the Milwaukee River was difficult, and even under the most favorable circumstances vessels drawing over 6 feet could not enter.

The first survey made by the United States with a view to the improvement of this harbor was made in 1836, and a map and proposed plan of improvement, together with a report on same, was published in Senate Doc. No. 175, Twenty-fifth Congress, second session. The plan therein proposed was almost identical with the one subsequently adopted, and provided for an artificial entrance to the Milwaukee River at about the same place where the present entrance is, the improvement of the original river mouth to be abandoned. This plan, however, was not approved, and in 1843-4 $50,000 was appropriated and expended in an attempt to improve the original river mouth. No satisfactory results were, however, obtained, and the attempt was finally abandoned.

The project for the present entrance was adopted in 1852, and since that time there has been appropriated for its furtherance the sum of $379,425.36. In addition, the city of Milwaukee has expended on account of the improvement of the harbor entrance the sum of $445,971.20.

The present harbor entrance consists of a channel 21 feet deep below the datum plane of harbor improvements, located between parallel piers, each 1,720 feet long, of which 1,120 feet were built by the city of Milwaukee and 600 feet by the United States.

In 1881 a project was adopted for the formation of a harbor of refuge at Milwaukee, to afford shelter to the general commerce of Lake Michigan. The harbor of refuge is formed by partially inclosing the northern portion of Milwaukee Bay by a breakwater 7,250 feet long, consisting of timber cribs placed on a stone foundation, thus affording an anchorage ground of about 417 acres outside of the 19-foot contour. The total amount appropriated for the breakwater is $955,650, and the present contract calls for its completion during the present calendar year.

On July 14, 1899, an estimate was submitted for replacing the timber superstructures of the harbor piers and of the breakwater with concrete. The estimated cost of these permanent superstructures was:

For the breakwater	$459,050
For the harbor piers	93,204
Total	552,254

As the item mentioned in the act of June 6, 1900, is very general in its nature, being for "necessary enlargement and suitable protection" of the harbor, the following letter was addressed to the Milwaukee Chamber of Commerce, the Milwaukee city authorities, and the Merchants and Manufacturers' Association, it being believed that thereby the commercial and shipping interests concerned would be given a full opportunity of making known what was desired:

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., June 18, 1900.

GENTLEMEN: The act of Congress approved June 6, 1900, "making provision for emergencies in river and harbor works, for certain surveys, and for the diversion of certain appropriations or modification of provisions heretofore made," provides as follows:

"SEC. 2. That the Secretary of War is hereby authorized to cause preliminary examinations and surveys to be made at the localities named in this section as hereinafter provided. In all cases a preliminary examination shall first be made, which shall embrace information concerning the commercial importance, present and prospective, of the river or harbor mentioned, and a report as to the advisability of its improvement. If upon such preliminary examination the proposed improvement is not deemed advisable, no further action shall be taken thereon without the further direction of Congress; but in case the report shall be to the effect that such river or harbor is worthy of improvement, the Secretary of War is hereby authorized, at his discretion, to authorize surveys to be made and the cost of improving such rivers or harbors to be estimated and to be reported to Congress, to wit:

"Milwaukee Harbor: With a view to necessary enlargement and suitable protection therefor."

I have been assigned the charge of making the preliminary examination for Milwaukee Harbor.

In order that my report may fully cover the case, I have to request the views of the Chamber of Commerce upon the advisability of the enlargement of Milwaukee Harbor, the nature of the works desired, and such information as to the commercial interests, both general and local, which will be benefited thereby as may be available.

Very respectfully,

J. G. WARREN,
Captain, Corps of Engineers.

The CHAMBER OF COMMERCE,
City of Milwaukee, Wis.

The only reply received was from the chamber of commerce, which appointed a very able committee of gentlemen prominent in commercial and transportation interests. This committee, after full hearings and careful deliberation, reported adversely on the proposed project for an outer harbor. Their report, which is complete and exhaustive, is herewith appended:

CHAMBER OF COMMERCE,
Milwaukee, August 1, 1900.

DEAR SIR: In response to your communication of June 18 with reference to an act of Congress approved June 6, 1900, making provision for preliminary examination and survey at Milwaukee Harbor with a view to necessary enlargement and suitable protection therefor, requesting the "views of the chamber of commerce upon the advisability of the proposed enlargement of Milwaukee Harbor, the nature of the works desired, and such information as to the commercial interests, both general and local, which will be benefited thereby as may be available," the president of the chamber of commerce, pursuant to a resolution adopted by the board of directors, appointed a committee of nine representative business men conversant with the shipping and dockage interests of Milwaukee to investigate the proposed harbor enlargement and report to the chamber of commerce. The committee thus appointed, upon thorough and careful consideration of the subject, has made the following report, which was adopted by the chamber of commerce to-day upon the unanimous recommendation of the board of directors:

"Your committee has carefully considered the proposed plan for an outer harbor in Milwaukee Bay south of the Straight Cut, and has examined the plan submitted by Mayor David S. Rose, and begs leave to report:

"That the harbor facilities of Milwaukee are not surpassed by any on the Great Lakes, considering the size of vessels now in use, as well as the depth of water maintained by the Government. The harbor of refuge, when completed, and the natural inner harbor will be sufficient for the needs of commerce of a city twice or thrice the size of Milwaukee.

"The bridges spanning the Milwaukee, Menominee, and Kinnickinnic rivers will, as necessities may require, have to be changed to bascule bridges, thereby permitting the removal of the center piers, thus enabling a channel to be maintained of sufficient depth and width for the largest vessels ever expected to navigate the Great Lakes. The deepening of slips and making dock property accessible to such vessels by maintaining the necessary depth of water will have to be solved by the owners of such dock property as fast as the demand for the same warrants the outlay.

"The improved dock property and the enterprises carried on thereon will, in due time, materially increase and add to the value of the taxable property of the city.

"The dredging of the main channels of our rivers will, as heretofore, have to be done at the expense of the city or at the expense of the United States Government. We are informed that the Government is now doing such work at Toledo and Chicago, and there is no reason why it should not at least bear part of such dredging expense in Milwaukee.

"No outer harbors are ever constructed where there are fair conditions existing for an inner harbor, and such conditions exist in the valleys of the Menominee and Kinnickinnic rivers in great abundance.

"It is urged that the entrance and exit to the proposed outer harbor, as shown on plan heretofore referred to, would, even in ordinary weather, be difficult and dangerous, and would, in bad and foggy weather, be doubly dangerous, in fact, impracticable; that entrance could not be effected in a northeast gale by sailing vessels, and would even be very dangerous for steamers; that in winter this port would be closed by ice, as the basin created would freeze and fill up with drift ice, and that Milwaukee would, in fact, become an ice-bound port.

"Notwithstanding the views expressed by some, there are others equally well informed who are of the opinion that in a very short time the basin proposed to be created, estimated at some 1,200 acres in area, would become a cesspool, owing to the discharge therein of sewage from city sewers. This sewage could not, as it does now, find its way into the lake readily, because of lack of current to take it out.

"Such condition would necessitate the building of an intercepting sewer for all city sewage, with a pumping station at the south end thereof to pump the entire mass into the lake at the southern extremity of the proposed outer sea wall. No one has at present any idea of the cost of such an immense undertaking, the funds for which, however, would have to be furnished by the taxpayers of this city.

"The lake front proposed to be protected by this sea wall could not be utilized by the city for dock purposes, as proposed by the advocates of this project, without first being acquired by the city, either by purchase or lease. It may be claimed by the promoters of this scheme that the land made would revert to the city. It is not to be supposed for one moment that the present owners of that water front would tamely submit to the loss of the same. Endless litigation, the cost of which can not be estimated, would be the result of an attempt on the part of the city to exercise any jurisdiction over any of that property without lease or purchase.

"All this cost of intercepting sewers and possible litigation would have to be met by the taxpayers, in addition to the expenditures the city would be obliged to make for new bridges and of keeping the rivers dredged to required depth so as not to detract from the value of dock property which has for over fifty years helped to meet the expenses of our city government by being on the city's tax roll.

"We recommend the adoption of the following resolution:

"*Resolved*, That after due deliberation and careful consideration of the subject referred to us we are obliged to report adversely on the proposed outer harbor project.

"John Johnson,
"D. M. Brigham,
"E. B. Simpson,
"W. H. Simpson,
"L. J. Petit,
"D. Vance,
"H. F. Whitcomb,
"F. H. Magdeburg,
"Alfred James,
"*Commitee.*

"Very respectfully,

"W. J. Langson,
"*Secretary.*"

Capt. J. G. Warren,
Corps of Engineers, U. S. A.
(In charge of harbor improvements, west shore of Lake Michigan.)

On July 19, 1900, a personal examination was made by this office, under my direction, of the rivers and canals that constitute the present interior harbor of Milwaukee. From observations made during this examination and from other sources, the accompanying map[1] was prepared, and on which is also shown the plan for the proposed outer harbor which was considered by the chamber of commerce committee. From this map it appears that the total navigable length of the rivers and canals is about 9½ miles, and the examination showed that the available dockage is far from being fully utilized.

In this connection attention is invited to the following quotation from the Milwaukee Sentinel of July 29, 1900:

> At the request of the Sentinel, City Engineer Poetsch last week made estimates of the number of feet of river front in the city that is now unimproved and which could be turned into suitable dock property. His figures show a total of over 5 miles, distributed as follows:

	Feet.
Kinnickinnic Valley	13,100
Menominee Valley	11,580
Upper Milwaukee River	3,500

A copy of the Milwaukee Sentinel of June 24, 1900, is also forwarded herewith,[1] and in which is given a rough map of the proposed outer harbor, with a description thereof.

The engineering features of the proposed improvement have not been considered by this office, as, from examinations made and from the information obtained, it appears that an outer harbor is neither necessary nor desirable. The present harbor of refuge is sufficient for its purpose, and the present interior harbor is far from being utilized to its fullest extent. The largest vessels engaged in the commerce of the lakes enter Milwaukee Harbor without difficulty

Without going into a careful estimate, it is evident that the proposed outer harbor would be very expensive, and that to extend the present breakwater and build another to the south of the present entrance, as has been proposed, would probably involve an expenditure of over $1,000,000.

It is believed that any probable benefits to be derived would not be commensurate with the cost of the proposed harbor, and that neither present nor prospective commerce demands any enlargement of the present project. When, however, the present interior harbor facilities shall have been fully utilized, should it be then demonstrated that turning basins were necessary, the construction of such turning basins might properly be undertaken by the United States in the interests of general commerce.

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[1] Not printed.

For the foregoing reasons, therefore, the improvement of the locality by the General Government in the manner contemplated by the act of June 6, 1900, is not advisable.

Very respectfully, your obedient servant,

J. G. WARREN,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, NORTHWEST DIVISION,
New York, August 9, 1900.

Respectfully forwarded to the Chief of Engineers, United States Army, concurring in the opinion of the district engineer "that neither the present nor prospective commerce of Milwaukee demand any enlargement of the present project," and that the improvement of the locality by the General Government in the manner contemplated by the act of June 6, 1900, is not advisable.

J. W. BARLOW,
Colonel, Corps of Engineers,
Division Engineer.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
November 1, 1900.

Respectfully submitted to the Secretary of War, concurring in the opinion of the local officer and of the division engineer that improvement of the locality by the General Government in the manner contemplated by the act of June 6, 1900, is not advisable.

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

[Third indorsement.]

WAR DEPARTMENT,
November 2, 1900.

The views of the local officer and of the division engineer, as concurred in by the Chief of Engineers, are approved.

ELIHU ROOT,
Secretary of War.

APPENDIX M M.

IMPROVEMENT OF CHICAGO AND CALUMET HARBORS AND CHICAGO AND ILLINOIS RIVERS, ILLINOIS, AND OF CALUMET RIVER, ILLINOIS AND INDIANA; CONSTRUCTION OF ILLINOIS AND MISSISSIPPI CANAL.

REPORT OF MAJOR J. H. WILLARD, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1901, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Chicago Harbor, Illinois.
2. Chicago River, Illinois.
3. Calumet Harbor, Illinois.
4. Calumet River, Illinois and Indiana.
5. Illinois River, Illinois.
6. Operating and care of Lagrange and Kampsville locks and dams, Illinois River.
7. Illinois and Mississippi Canal.
8. Survey of Upper Illinois and Lower Des Plaines rivers, Illinois.

EXAMINATIONS.

9. Illinois and Des Plaines rivers, Illinois.
10. Rock River, Illinois.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., July 24, 1901.

GENERAL: I have the honor to transmit herewith annual reports upon the works in my charge for the fiscal year ending June 30, 1901.

* * * * * * *

Very respectfully, your obedient servant,

J. H. WILLARD,
Major, Corps of Engineers.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

M M 1.

IMPROVEMENT OF CHICAGO HARBOR, ILLINOIS.

The project for this harbor was adopted in 1870 and modified in 1878. By act of July 3, 1896, the project was again modified to include dredging Chicago River, or the inner harbor, to admit passage by vessels drawing 16 feet of water.

The project of 1870 as modified in 1878 contemplated—

(*a*) The formation of an outer harbor or basin by inclosing a portion of Lake Michigan for the purpose of increasing the harbor facilities of Chicago and to give relief to the overcrowded river.

(*b*) The construction of an exterior breakwater of crib work filled with stone in deep water in Lake Michigan and wholly detached from the shore, north of the entrance to Chicago River, to shelter the entrance to the river and the outer harbor from northerly storms, and to form a harbor of refuge at the southern end of Lake Michigan. The project also included the maintenance by dredging of the channel at the entrance to Chicago River as far west as to Pine street, and the piers so far as they project beyond the existing shore line. All of the project has been completed except dredging the outer harbor.

(*c*) Under the river and harbor act of June 3, 1896, the Chicago River, which is the inner harbor, has been directed improved for vessels drawing 16 feet of water. This work is reported upon separately as "Improving Chicago River, Illinois."

CONDITION OF THE WORK JUNE 30, 1901.

Outer basin.—This basin originally covered 455 acres of the area of Lake Michigan, of which 270 acres lie seaward of the dock line established by the Secretary of War September 22, 1890, and 185 acres west of this dock line. The dock line is about 1,300 feet east of the right of way of the Illinois Central Railroad and 2,000 feet distant from and parallel to the easterly breakwater of the basin.

Under authority granted by the Secretary of War July 24, 1895, a bulkhead has been constructed along the dock line, and the area shoreward of the dock line is now being filled in for a public park.

New agreements having been made between the War Department and the proper officers of the city of Chicago for depositing the dredged material, a contract was let for dredging the Chicago River from Rush street eastward, for removing the bar at the entrance to the river, and for dredging the inner harbor or basin, so far as the funds would permit.

Congress having authorized a project depth of 21 feet for the river, it would seem proper to secure a like navigable depth at the entrance, but the appropriation of March 3, 1899, available for the present work, was based upon Major Marshall's report of July 16, 1897, in which he recommended dredging the outer basin to a depth of 20 feet, at a cost of $509,960.

The tunnels under the Chicago River do not admit boats drawing over 17 feet, but there is no doubt that they will be lowered or removed at an early day, the only question being who shall bear the cost.

In anticipation of this work the sanitary trustees are dredging the South Branch of the river to 26 feet below hydraulic grade, beginning to widen it to 200 feet, and replacing the most obstructive bridges with bascule bridges of approved types; all on plans approved by the Secretary of War.

In view of these facts and to secure a navigable depth for boats now in service or building that can load to 22 feet, I recommend that authority be given by Congress to dredge to a depth of 26 feet below low water in the harbor and to 26 feet below hydraulic grade in the inner harbor. The increased depth in the harbor will allow for possible fill and insure against heavily loaded vessels pounding on the bottom in a swell, while that for the inner harbor and river will both allow for fill and also for the drop of the river surface upstream in the South Branch due to the reversed slope of the river caused by the discharge of the sanitary canal required by State laws.

Owing to the general dissatisfaction of the people living along the lake shore between Sixteenth street and Thirty-ninth street with the selection of the inshore dumping ground, by agreement with the proper officer of the city and approved by the Secretary of War, as provided by law, and also to the general objection on the part of the health department of the city to the 2-mile ground heretofore acceptable on account of the danger to the water supply, I am of the opinion that all future dumping should be in accordance with the wishes of the people and the views of the health officers, and be made at least 8 miles lakeward and far removed from the city intakes, to avoid all danger of polluting the water supply. This rule should apply, in any event, to all future contracts made by the United States or others for dredging the Chicago River, into which the greatest part of the sewage flows or is planned to flow when the intercepts are finished. The people have paid an enormous sum to divert the sewage from the lake in the interest of the public health, and they feel entitled to protection at the hands of the United States.

The change will increase the cost of the work considerably, perhaps as much as three times, either in demurrage and delays on account of stormy weather for such plant as is now in use or for the construction of seagoing plant. The latter would not be justified except for a continuing contract for a large amount.

I submit no estimate for such a project, but I recommend an appropriation of $230,000 for continuing the project in accordance with Major Marshall's report of 1897, as follows:

For dredging the harbor, approach, and river to Rush street, to 26 feet depth below low water	$200,000
For necessary repairs to constructions	10,000
For seagoing steam vessel for general use in this district	20,000
Total	230,000

EXTERIOR BREAKWATER.

This work is situated about 1 mile north of the entrance to Chicago River, which it shelters against northerly storms. The breakwater is 5,413 feet in length, 30 feet wide, and constructed in water varying from 18 to 32 feet in depth. All of it, except 1,200 linear feet which is on a foundation of riprap stone, has been built upon the natural sand and clay bottom.

This work has been successful, and well subserves its object. It was begun in 1880 and completed in 1890.

No work was done upon it during the year.

PROPOSED APPLICATION OF FUNDS NOW ON HAND, AND THOSE ASKED FOR, FOR FISCAL YEAR ENDING JUNE 30, 1902.

It is proposed to apply these funds to the dredging of the outer basin and to the maintenance of existing work.

Money statement.

July 1, 1900, balance unexpended		$102,875.61
June 30, 1901, amount expended during fiscal year		8,297.01
July 1, 1901, balance unexpended		[1] 94,578.60
July 1, 1901, amount covered by uncompleted contracts		85,158.99
Amount (estimated) required for completion of existing project		457,965.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901:		
For works of improvement	$220,000.00	
For maintenance of improvement	10,000.00	
		230,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

APPROPRIATIONS.

By act of—	
July 11, 1870	$100,000.00
March 3, 1871	100,000.00
June 10, 1872	90,000.00
March 3, 1873	90,000.00
June 23, 1874	75,000.00
March 3, 1875	78,000.00
August 3, 1876	5,000.00
June 18, 1878	75,000.00
March 3, 1879	75,000.00
June 14, 1880	145,000.00
March 3, 1881	150,000.00
August 2, 1882	200,000.00
July 5, 1884	100,000.00
August 5, 1886	75,000.00
August 11, 1888	200,000.00
September 19, 1890	100,000.00

By act of—	
July 13, 1892	$72,000.00
August 18, 1894	80,000.00
March 3, 1899	100,000.00
Total appropriated	1,910,000.00
Received from all sources since 1870 (transfer of tugs, sales, etc)	630.16
Total	1,910,630.16
Expenditures to June 30, 1901	1,816,551.56
Balance unexpended June 30, 1901	94,078.60

COMMERCIAL STATISTICS.

Amount of revenue collected during fiscal year 1901, $8,327,635.42.

Arrivals and clearances of vessels, Chicago Harbor.

	Arrivals.		Clearances.	
	Number.	Tons.	Number.	Tons.
Steam	5,924	4,493,095	5,943	4,461,671
Sail	1,203	419,205	1,224	439,736
Total	7,127	4,912,300	7,167	4,901,407

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[1] Includes $500 allotted for expenses office Chief of Engineers for fiscal year 1901.

Receipts and shipments by lake at Chicago during calendar year 1900.

Receipts.	Tons.	Shipments.	Tons.
Coal	856,599	Flour	227,608
Iron, iron ore, etc	61,274	Grain	2,094,265
Fish	3,155	Lead and bullion	22,163
Lumber, wood, etc	1,263,871	Lard	18,055
Flour, salt, sugar, sirup	368,007	Meat	4,453
Cement, plaster, etc	235,163	Sugar and sirup	31,872
Potatoes	10,697	Coffee and tea	3,375
Green fruit	54,700	Steel rails, etc	7,914
Coffee and tea	16,704	Iron	14,980
Grain	10,599	Mill stuffs, etc	39,180
Liquors	5,737	Corn meal and oatmeal	2,569
Oils and paints	7,067	Oil and oil cake	20,081
Pease and beans	7,725	Glucose	13,759
Stone and marble	9,431	Miscellaneous merchandise	202,695
Miscellaneous merchandise	259,372	Total	2,702,969
Total	3,170,101		

Comparisons of receipts and shipments for years 1893 to 1900, inclusive.

Year.	Tons.	Year.	Tons.
1893	7,958,963	1897	7,149,759
1894	7,209,236	1898	7,391,454
1895	7,205,942	1899	6,189,365
1896	6,347,163	1900	5,873,070

List of contracts in force during fiscal year ending June 30, 1901, Chicago Harbor, Illinois.

Name and address of contractor.	Nature of contract.	Date.	To expire—
Lydon & Drews Co., Chicago, Ill	Dredging	Mar. 25, 1901	July 15, 1902

REPORT OF MR. G. A. M. LILJENCRANTZ, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., July 1, 1901.

MAJOR: I have the honor to submit herewith a report on operations in Chicago Harbor, Ill., during the fiscal year ending June 30, 1901:

There was no contract in force at the beginning of the year for the improvement of this harbor, but on the 25th of March, 1901, a contract was entered into with the Lydon & Drews Company, of Chicago, Ill. This contract was for the same work of dredging contracted for during the previous year with the Chicago Star Construction and Dredging Company, but from which work that firm had been relieved by the Secretary of War, as stated in last year's report. The price bid and accepted for the new contract was less than one-half cent in excess of that of last year, or 7.45 cents per cubic yard.

WORK DONE DURING THE YEAR.

Work under the contract was begun with one dredge (a new machine, just completed, having a dipper with a capacity of 8½ cubic yards, water measurement) on the 2d day of May of this year. It was expected that with this powerful dredge the monthly minimum amount of material required by the contract—100,000 cubic yards—could be removed, but only 72 per cent of that amount was removed during the first month. This was partly owing to breakages of weaker parts of the heretofore untried machine, partly to delays by strong northerly winds, and partly to the comparatively shallow dredging in the river channel.

On the 11th of June an additional dredge was placed on the work, with the result that at the close of the month an aggregate of 128,040.5 cubic yards had been removed by the combined work of the two dredges.

At the close of the year there had been removed in all 200,256 cubic yards of material. By this work the river channel west of the United States life-saving station was practically completed, and the bar at the approach to the harbor more than half removed, as shown on the sketch[1] respectfully submitted herewith. This work also represents the total work done under the contract.

WORK PROPOSED FOR THE FISCAL YEAR ENDING JUNE 30, 1902.

It is proposed to continue with work under the contract during the ensuing year; to first complete the unfinished part of the river channel and that of the outside bar, and then proceed with the deepening of the "Outer Basin" from the river entrance as far southward as available funds will permit.

I am, Major, very respectfully, your obedient servant,

G. A. M. Liljencrantz,
Assistant Engineer.

Maj. J. H. Willard,
Corps of Engineers, U. S. A.

M M 2.

IMPROVEMENT OF CHICAGO RIVER, ILLINOIS.

This river constitutes the inner harbor of Chicago, Ill. Its navigable parts lie wholly within the city limits of Chicago.

In the Annual Report of the Chief of Engineers for 1893, page 2974, may be found a full report upon this stream and its needed improvement, and in his annual report of 1897, page 2793, a history of the improvement and some detailed information as to the obstructions to navigation existing along its channels.

The present project was adopted by Congress in the river and harbor act of June 3, 1896, and modified by the sundry civil act of June 4, 1897. It contemplates dredging the river and its branches from the mouth of the river to the stock yards on the south branch, and to Belmont avenue on the north branch, as far as may be admitted by existing docks and wharves, to allow passage by vessels drawing 16 feet of water; also to acquire title to and cut away certain obstructive bends and projecting docks that narrow and obstruct the channel.

Since the flow of the Chicago River has been reversed through the south branch by the discharge into the sanitary canal, the slope has also been reversed from the lake upstream, and the depth correspondingly reduced. To compensate for this loss in navigable depth the sanitary trustees have undertaken to dredge to a depth of 26 feet below hydraulic grade, and will continue to dredge to that depth while enlarging the river to 200 feet width upon plans approved by the Secretary of War. To reduce the dangers to navigation by the upstream flow, and to provide for the discharge of 20,000 cubic feet per minute for each 100,000 inhabitants of the sanitary district, as required by State law, the trustees have submitted plans for seven bascule bridges, which have been approved by the Secretary of War upon the recommendation of the Chief of Engineers.

The first bridge put under contract was at Taylor street, and was accepted in May, 1901, and the second, the railway bridge just south, should be ready for operation early in August. Condemnation proceedings have been started for the necessary lands for the 200 feet widening, and the work will be pushed rapidly. The city is also undertaking to replace the most obstructive bridges on the north branch with those of bascule type, but, being straitened for funds, progress is slow. The tunnel question is still in the courts to determine who shall bear the cost, the city or the traction companies who use them. Until the provisions of the river and harbor act of March 3, 1899, are complied with, viz, "that all the work of removing and reconstructing bridges and piers and lowering tunnels necessary to permit a practicable channel with said depth to be obtained (21 feet) shall be done or caused to be done by the city of Chicago without expense to the United States," no work for the general improvement of the river can be undertaken.

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[1] Not printed.

But inasmuch as a good portion of the dredging in the south branch will be done by the sanitary trustees and the bridges are being replaced as rapidly as possible with due regard to city traffic, it seems proper to recommend supplementing the project of 1893 and the improvements begun by the sanitary trustees by making turning basins at suitable points in each branch of the river, for which there is great need. I had recommended using the unexpended balance for beginning such a basin at the junction of the South Branch and the South Fork, but it was held that such work would be a new project and therefore would require the authority of Congress. No special surveys would be necessary for this purpose, but only such as would be necessary to delimit the lands to be acquired and estimate the cost of construction.

The prices of the lands would depend upon the location. With dumping ground in the lake eight miles from shore, the dredging should be estimated at 35 cents the cubic yard and the docking not less than $25 the linear foot, both on account of the increased depth and the rise in the prices of timber.

It would seem proper also to follow the lead of the sanitary trustees and increase the project depth to 26 feet below hydraulic grade, to provide for possible fill and to allow for the drop at the junction with the sanitary canal.

The turning basins should be provided in advance, although their need is independent of any work now going on. The balance available June 30, 1901, free of all liabilities and contracts, was $193,542.92, which, with the $75,000 remaining from original estimate to complete the project, might be used for beginning this work, if authorized by Congress. The actual cost of two turning basins can not be estimated until the work is authorized and the sites chosen, but judging from average prices paid for lands taken under the project of 1893, as approved by the acts of 1896 and 1897, $500,000 should be ample. At least $50,000 should be reserved for maintenance of the channel dredged by the United States under the project.

WIDENING AND DOCKING THE RIVER.

Abstracts of title to all of the lands required under the project for removing obstructive dock corners and docking lands have been secured, and under contract with Lydon & Drews Company, dated April 14, 1899, fifteen tracts have been improved and two are in progress.

Report of Assistant Engineer G. A. M. Liljencrantz, showing in detail the work done during the fiscal year, is herewith.

PROPOSED APPLICATION OF FUNDS NOW AVAILABLE AND THOSE ASKED FOR FOR FISCAL YEAR ENDING JUNE 30, 1902.

It is proposed to continue the work of removing obstructive dock corners and docking under contract now in force.

Money statement.

July 1, 1900, balance unexpended	$278,441.46
June 30, 1901, amount expended during fiscal year	58,949.94
July 1, 1901, balance unexpended	[1] 229,491.52
July 1, 1901, amount covered by uncompleted contracts	30,948.60
Amount (estimated) required for completion of existing project	75,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	75,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

Act of June 3, 1896	$50,000.00
Sundry civil act, June 4, 1897	113,000.00
Sundry civil act, July 1, 1898	400,000.00
Sundry civil act, June 6, 1900	62,000.00
Total	625,000.00
Expenditures to June 30, 1901 (exclusive of $25,000 allotted from appropriation for Chicago Harbor of August 18, 1894)	400,508.48
Balance unexpended July 1, 1901	224,491.52

List of contracts in force during fiscal year ending June 30, 1901, Chicago River, Illinois.

Name and address of contractor.	Nature of contract.	Date.	To expire—	Extended.
Lydon & Drews Co., Chicago, Ill.	Dredging and constructing docks.	Apr. 14, 1899	Sept. 30, 1900	Dec. 31, 1901

REPORT OF MR. G. A. M. LILJENCRANTZ, ASSISTANT ENGINEER.

United States Engineer Office,
Chicago, Ill., July 1, 1901.

Major: I have the honor to submit herewith a report on operations in Chicago River, Illinois, during the fiscal year ending June 30, 1901.

There was one contract in force during the year for the improvement of this river, viz, with the Lydon & Drews Company, of Chicago, Ill., dated April 14, 1899, for the removal of the most obstructive bends in the river and for the construction of docks in front of the remaining tracts of land, in accordance with project adopted by Congress in the river and harbor act of June 3, 1896, and modified by sundry civil act of June 4, 1899.

WORK DONE DURING THE YEAR.

Work under the contract was continued during the year, though with frequent interruptions for various reasons. The operations under the contract are accounted for under two different heads, as suggested by the difference in character of the work done under each, viz:

A. Securing titles to land proposed to be removed, and

B. Actual operations of removing the land and constructing the docks.

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[1] Includes $500 allotted for expenses office Chief of Engineers for fiscal year 1902.

A. *Securing the titles to land.*—At the beginning of the year there were three tracts for which the titles had not been secured, viz, for tracts Nos. 6, 8, and 9 on the South Branch. These were, however, secured during the year, but the title, as shown by the deed and abstract for tract No. 8, forwarded to the Department of Justice through the United States district attorney in this district on the 16th of May, 1901, has not yet been formally approved by the Attorney-General.

Nothing is to be paid for this tract of land, however, as by a special agreement, approved by the Department, the originally proposed improvement was modified, so that the owners, waiving the payment for the land, were given a longer and straight dock.

B. *Removing land and constructing docks.*—The improvement of the following tracts was completed during the year, to wit:

South Branch, No. 1*b*, completed on September 29, 1900.
South Branch, No. 6, completed on August 7, 1900.
South Branch, No. 10, completed on November 6, 1900.
South Branch, No. 11, completed on January 7, 1901.
North Branch, No. 1, completed on August 30, 1900.
North Branch, No. 3*a*, completed on July 11, 1900.
North Branch, No. 5, completed on July 17, 1900.

These tracts, representing the work done and completed during the year, comprised the following amount of work in the aggregate:

Land removed, cubic yards, 31,845; new docks built, linear feet, 1,596.2.

These amounts do not include work done on some of the above tracts during the previous fiscal year.

In addition to the work just stated as having been completed during the year, operations have been in progress on two other tracts, the only ones now remaining unimproved; both of these are nearing completion. The removal of both of these was done during the month of June, and the amount of dredging done for that purpose—27,958.4 cubic yards—should properly be added to the figures given above as the year's work, making this 59,803.4 cubic yards.

TOTAL WORK DONE UNDER THE CONTRACT.

Since the beginning of operations under the contract all the tracts proposed to be improved under the approved project have been completed, except—

Tracts 3*b* and 4 on the North Branch, the improvement of which was dispensed with, as stated in last year's report, and

Tracts 2 and 8 on the South Branch, which are at the present time in process of being improved.

In brief, the total amount of work completed under the contract is represented by—

Land removed, cubic yards, 121,913.4; new docks built, linear feet, 4,355.2.

WORK PROPOSED FOR THE ENSUING YEAR.

It is proposed to continue and complete during the year ending June 30, 1902, the two tracts now in progress of improvement, which will terminate the contract; also to prepare a more exhaustive report on all the work done under the contract, with tables showing in detail the progress of the work, total amounts of materials used, the cost of the work in whole and in part, and the average cost per linear foot of dock constructed, all of which is believed will furnish data of general interest in connection with works of this character.

I am, major, very respectfully, your obedient servant,

G. A. M. Liljencrantz,
Assistant Engineer.

To Maj. J. H. Willard,
Corps of Engineer, U. S. A.

M M 3.

IMPROVEMENT OF CALUMET HARBOR, ILLINOIS.

The object of the work is to provide a deep entrance to the Calument River and the port of South Chicago, which object is effected in the usual manner by first protecting the proposed channel against drift by parellel piers or jetties (in this case 300 feet apart) projecting into the lake from the shore at the river's mouth, and by dredging between them to the proper depth.

CONDITION OF THE WORK JUNE 30, 1896.

Work was begun on this harbor in 1870, and prior to June 30, 1896, 2,020 linear feet of the south pier and 3,640 feet of the north pier had been completed, and a channel 16 feet in depth between the piers had been secured and maintained, which completed the old project for this improvement.

CONDITION OF THE WORK JUNE 30, 1901.

The river and harbor act of June 3, 1896, adopted for this harbor a project submitted June 30, 1895, which provided for a channel depth of 20 feet and prolongation of the south pier 1,200 linear feet and the north pier 500 linear feet.

In February, 1896, a project supplementary to that of June 30, 1895, was submitted and published as House Ex. Doc. No. 277 (see also Report of Chief of Engineers, 1896, p. 2584), which covered not only the requirements of the entrance to Calumet River or the present harbor, but all the present needs of this locality. This extended project contemplated an outer breakwater, in continuation of the north pier of the Illinois Steel Company's harbor, to shelter the entrance to Calumet River and to form a sheltered roadstead, to be dredged to 20 feet depth; the extension of the south pier 800 linear feet and dredging the entrance to the river and the river itself for a distance of 2 miles for a width of 200 feet and to a depth of 20 feet.

Congress, in making appropriations for Calumet Harbor, June 3, 1896, adopted the project of June 30, 1895, but in appropriating for the river adopted that part of the later project of February, 1896, relating to the 20-foot channel in Calumet River.

This appropriation of June 3, 1896, was expended in prolonging the south pier of Calumet Harbor 800 linear feet, and in dredging the channel to 20-foot depth to communicate with the channel of the Calumet River, which for 2 miles of its length has, under the provisions of the same act, been dredged to a similar depth.

At present there is a good channel 20 feet deep at present stage of water between the piers, but storms have somewhat filled the channel seaward of the piers with drifting sand. Vessels of the largest size and deepest draft known to the Great Lakes now frequent this the most capacious artificial harbor on Lake Michigan.

At the close of the fiscal year ending June 30, 1900, the construction of the first or outer breakwater, 4,400 feet long, running due east from the end of the Illinois Steel Company's north pier, was well under way. The foundation trench had been dug and piles driven for 1,000 feet, 13 cribs, 18 courses high and 24 feet wide, had been built, and 8 cribs sunk in position and filled with stone.

During the fiscal year 1901 the trench and 700 linear feet of foundation were prepared, and 1,500 linear feet of stone base for the cribs of 30 feet width was placed. All the cribs on pile foundation were sunk and filled with stone, and those for the stone foundation were built to include No. 32 and sunk in the line to include No. 29. The superstructure, 6 feet high, had been placed, filled with stone, and decked for a distance of 1,700 feet from the shore end, and 2,529 linear feet of ice guard bolted on. The contractors have been very successful in maintaining a true alignment in both directions and in the rapid construction of the cribs in spite of the scarcity of dimension timber. The plant is equipped with pneumatic tools, augers, gain and dovetail cutters, and traveling cranes, and consequently the fitting is more rapid and sure than by the old hand methods.

Hardly any material or work has been objected to. With an open season, and unless delayed by lack of timber, this breakwater should be finished before the close of navigation. In any case it will be finished before the end of the fiscal year 1902.

The general project for Calumet Harbor, or the port of South Chicago, as it is termed in custom-house papers, is based upon the report of Maj. William L. Marshall, Corps of Engineers, dated February 21, 1896, and contemplates the following improvements:

1. A breakwater, or breakwaters, affording such shelter that at all times vessels may safely enter the harbors there.

2. An extension of one or both piers of Calumet Harbor (inner) which may be much less in extent if the outer breakwater is built than already proposed.

3. A deepening of the harbor entrance to 20 feet, and a deepening to 20 feet, 200 feet wide, of the channel of Calumet River from its mouth about 2 miles upstream.

As this project was not formally adopted until March 3, 1899, when a continuing contract was authorized, work was limited to the inner harbor under the project of June 30, 1895, and therefore the expenditures were not quite the same although in harmony with the later project. More work was done under No. 2 than would have been required had the last project been adopted.

In connection with the east and west breakwater a southerly or southeasterly offshore breakwater was indicated with a reservation that possibly it might not be required if the east and west breakwater gave adequate protection against northeasterly storms. The second breakwater was to begin at a point about 2,500 feet due south of the east end of the east and west breakwater and to be extended in a southeasterly direction as far as found necessary.

It has been suggested by those interested in the navigation of the Calumet Harbor and River that a better protection would be given to the roadstead and inner harbor by substituting for the detached breakwater an extension of the east and west breakwater about 2,500 feet in a southeasterly direction. This, however, it is held can not be done without the authority of Congress.

With regard to the dredging, a depth of 20 feet is not sufficient for the class of boats even now seeking the Calumet trade, some of which could load to 22 feet if a navigable depth were provided.

To secure even 20 feet it is necessary to dredge to a greater depth, and in order to provide for possible fill and for the fluctuations in the lake levels, at least 26 feet should be authorized.

Under the orders of Congress the Deep Water Board was directed to prepare estimates for depths of 21 and of 30 feet, and estimates for such depths were made for all the harbors and rivers in this district upon the request of the board.

Ships are increasing in all dimensions and already a line has been put in operation between Chicago and Liverpool, and the first steamship has completed the round trip from the port of Chicago.

Congress has authorized 21 feet as the project depth of Chicago River, and even with the improvements contemplated by the United States and those in progress by the sanitary trustees under plans approved by the Secretary of War, Chicago River will not be of sufficient capacity for the business of the city.

The Calumet district is growing rapidly, large plants and elevators have been put up and others are under construction or planned, and the depth of water should be increased to meet this growth.

The earlier work is in need of repair due largely to the injuries done by fishermen. The officer in charge has no police powers, and has not been successful in getting aid from the city. Several years ago the Chicago Harbor works were cleared by the revenue cutter, but there is no boat in this district now for like service.

The old United States dock or revetment in front of the life-saving station should be reconstructed or the site abandoned. The Illinois Steel Company has suggested giving a site on their land on the outer harbor in exchange, which might require legislation.

With the change made by the construction of the outer harbor the present location of the life-saving station is of small value. It should be changed for one suited to its purpose.

It is proposed to continue the work now under contract to make necessary repairs to the piers of the inner harbor, and to maintain the 2-mile channel of the inner harbor and river. The report of Assistant Engineer G. A. M. Liljencrantz, herewith, furnishes the details of operations.

Whether it be held that the original project be carried out or modified upon the lines suggested, early completion of the work is strongly desired by all interests, and the full amount can be expended to advantage on continuing contracts for the dredging and such other work as authorized.

PROPOSED APPLICATION OF FUNDS NOW AVAILABLE AND THOSE ASKED FOR FOR FISCAL YEAR ENDING JUNE 30, 1902.

It is proposed to apply these funds to continuing the construction of the outer breakwater under contract and to the maintenance of the existing work and channel depths.

Money statement.

July 1, 1900, balance unexpended	$329, 248. 35
Amount appropriated by sundry civil act approved March 3, 1901	255, 000. 00
	584, 248. 35
June 30, 1901, amount expended during fiscal year	144, 748. 19
July 1, 1901, balance unexpended	439, 500. 16
July 1, 1901, amount covered by uncompleted contracts	193, 554. 06
Amount (estimated) required for completion of existing project	419, 480. 00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	419, 480. 00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

By act of—	
July 11, 1870	$50,000.00
March 3, 1871	50,000.00
June 10, 1872	40,000.00
March 3, 1873	40,000.00
June 23, 1874	25,000.00
March 3, 1875	25,000.00
August 3, 1876	20,000.00
June 18, 1878	15,000.00
March 3, 1879	12,000.00
June 14, 1880	20,000.00
March 3, 1881	30,000.00
August 2, 1882	35,000.00
July 5, 1884	20,000.00
August 5, 1886	10,000.00
By act of—	
August 11, 1888	$20,400.00
September 19, 1890	20,000.00
July 13, 1892	15,000.00
August 18, 1894	15,000.00
June 3, 1896	75,000.00
March 3, 1899	150,000.00
June 6, 1900	185,350.00
March 3, 1901	255,000.00
Total	1,127,750.00
Expended to June 30, 1901	688,249.84
Balance unexpended June 30, 1901	439,500.16

List of contracts in force during fiscal year ending June 30, 1901, Calumet Harbor, Illinois.

Name and address of contractor.	Nature of contract.	Date.	To expire—
Hausler & Lutz Towing and Dock Co., South Chicago, Ill.	Constructing breakwater	July 7, 1899	Dec. 31, 1901

COMMERCIAL STATISTICS.

Amount of revenue collected at nearest port of entry (Chicago) during fiscal year 1901, $8,327,635.42.

Arrivals and clearances of vessels at Calumet Harbor.

	Arrived.		Cleared.	
	Number.	Tons.	Number.	Tons.
Steam	915	1,446,398	975	1,545,061
Sail	324	495,873	327	485,173
Total	1,239	1,942,271	1,302	2,030,234

Receipts and shipments by lake at South Chicago, Ill., during calendar year 1900.

Receipts.	Tons.	Shipments.	Tons.
Coal	126,795	Steel rails	1,555
Iron and iron ore	2,333,381	Coal	1,850
Salt	177,803	Iron	
Grain	10,290	Oil	35,016
Cement and plaster	35,400	Grain	970,995
Lumber, wood, etc	80,520	Miscellaneous	3,295
Miscellaneous	6,774	Total	1,012,711
Total	2,770,963		

Comparison of receipts and shipments by lake at South Chicago, Ill., for calendar years 1893 to 1900, inclusive.

Year.	Tons.	Year.	Tons.
1893	903,379	1897	3,493,218
1894	1,436,897	1898	4,117,526
1895	2,857,750	1899	3,229,874
1896	2,973,724	1900	3,783,674

REPORT OF MR. G. A. M. LILJENCRANTZ, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., July 1, 1901.

MAJOR: I have the honor to submit herewith a report on operations in Calumet Harbor, Illinois, during the fiscal year ending June 30, 1901.

There was one contract in force during the year for the improvement of this harbor, viz, with the Hausler & Lutz Towing and Dock Company, of South Chicago, Ill., dated July 7, 1899, for the construction of a breakwater, 4,400 feet long, to run due east and west from the outer end of the Illinois Steel Company's North Harbor pier.

WORK DONE DURING THE YEAR.

Work under the contract was continued during the year, until the 14th of January, 1901, when operations were suspended for the winter. The reason for continuing to such a late date was a desire to secure as much as possible of the ice guard on the work, to protect this against damage by floating ice in the coming early spring. Operations were resumed on the 25th of March, but little actual work was done before the latter part of April owing chiefly to delay in the delivery of timber.

In brief, the year's work consisted in:

1. The preparation of 700 linear feet of pile foundation (including dredging of trench) and 1,500 linear feet of stone foundation.

2. The construction of four cribs (Nos. 14, 15, 16, and 17) 24 feet wide and 100 feet long each; the first of these 18 courses, the other three 20 courses high, all sunk on pile foundation.

3. The construction of fifteen cribs (Nos. 18 to 32, inclusive) 30 feet wide and 100 feet long each; all 20 courses in height except No. 32, which is 22 courses, and all sunk, or to be sunk, on stone foundation.

4. The sinking of the 24-foot cribs on pile foundation and twelve of the 30-foot cribs on stone foundation and filling of all these cribs with stone.

5. The construction of 1,700 linear feet of superstructure, including the decking.

6. The placing of 2,529 linear feet of the ice guard on a part of the completed pier, and finally,

7. The forming of a protection to the opening formed on the north side of the pier at the junction between the 24-foot and the 30-foot cribs by a row of white oak piles connected with the pier by means of waling pieces and tie-rods.

It having been found that the length of 3 feet for the plank in the ice guard was insufficient to secure a strong hold on the pier, a section of this having been torn off in a northerly gale, it was deemed necessary to increase the length of the plank to 4 feet on the north side of the pier, which side is most exposed, and this was done for a distance of 645 linear feet of the work accounted for above, and it is proposed to maintain this length for the rest of the pier.

In this, the year's work, the following labor and materials were furnished, to wit:

Dredging (for a trench)	cubic yards..	5,161
Pine piles	number..	350
Wihte oak piles (in protection)	do....	16
Hemlock timber	feet B. M..	2,372,824
Pine timber	do....	578,920
Oak timber	do....	32,118.5
Pine decking	do....	187,000
Wrought-iron screw bolts	pounds..	3,195
Wrought-iron driftbolts	do....	261,130
Wrought-iron spikes	do....	9,519
Stone (in cribs and foundation)	cords..	14,024.35

TOTAL WORK DONE UNDER THE CONTRACT.

Since the beginning of operations under the existing contract, the following work, in brief, has been accomplished:

Seventeen hundred linear feet of the pier, 24 feet wide, has been completed, including pile foundation; cribs framed, sunk, filled with stone, covered with decking, and in part provided with ice guard; 12 cribs, 100 feet long and 30 feet wide each, have been sunk on stone foundation, which latter has been further extended 300 linear feet beyond the last crib sunk.

In this work the following labor and materials have been furnished, to wit:

Dredging	cubic yards..	7,412
Pine piles	number..	884
White-oak piles	do....	16
Hemlock timber	feet B. M..	3,912,870
Pine timber	do....	688,640
Oak plank	do....	32,118.5
Pine decking	do....	187,000
Wrought-iron screwbolts	pounds..	12,659
Wrought-iron driftbolts	do....	380,956
Wrought-iron spikes	do....	9,519
Stone	cords..	16,413.04

CONDITION OF THE WORKS AT THE CLOSE OF THE FISCAL YEAR.

The north and south river-piers are generally in fair or good condition, except about 400 feet of the old crib work on the latter pier, which, though in a rather dilapidated condition, might without serious results remain untouched a few years longer. The old revetment at the foot of the original north pier, however, is in the most deplorable condition and in need of reconstruction as soon as possible. A part of this revetment is in front of the United States life-saving station and the United States office and boathouse, and it is positively unsafe to take the rowboats across this dock. The channel between the piers is from 19 to 20 feet in depth, but a shoal has formed in the lake at the entrance to the harbor. A tracing[1] showing work done during the year is respectfully submitted herewith.

WORK PROPOSED FOR THE YEAR ENDING JUNE 30, 1902.

It is proposed to continue and complete during the ensuing year the work now under contract and, when completed, to advertise for proposals for dredging of the sheltered area, in conformity to the approved project.

I am, major, very respectfully, your obedient servant,

G. A. M. Liljencrantz,
Assistant Engineer.

Maj. J. H. Willard,
Corps of Engineers, U. S. A.

M M 4.

IMPROVEMENT OF CALUMET RIVER, ILLINOIS AND INDIANA.

The object of this work as originally projected was to secure a channel 16 feet in depth, 200 feet wide, from the mouth of the river to one-half mile east of Hammond, Ind., to increase the facilities for handling the commerce of this region and to give relief to the overcrowded port of Chicago.

The history of the work, especially as regards the conditions imposed by various river and harbor acts of Congress, may be found in the annual reports of the Chief of Engineers prior to 1890, especial attention being invited to the report of 1889, page 2142.

The United States have acquired the right of way and releases from claims for damages by reason of the improvement of Calumet River over the stretch from the mouth of the river to the outlet from Lake Calumet, the limits of the improved channel to be dock lines 200 feet apart, which have been established by authority of the Secretary of War.

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[1] Not printed.

The improvement above the forks, or from the forks to one-half mile east of Hammond, Ind., can not be made of the full width of 200 feet until the right of way and releases from damages have been acquired by the United States. In view of this fact, under the provisions of various acts of Congress the work has been subdivided into two sections: (1) From the mouth of the river to the forks of the Calumet (below the forks); (2) from the forks to one-half mile east of Hammond, Ind.

No steps have been authorized by Congress or undertaken by parties interested to secure rights of way and releases from damage claims for the improvement above the forks, and consequently work has been carried on in desultory fashion over that section in an attempt to secure a channel 60 feet wide and 10 feet deep. This section is part of an old river, now dead, or without current to carry off the filth cast into it from slaughterhouses and manufactories near Hammond and from sewers of the town. The dredged channels were filled up with filthy deposits as fast as excavated, and after repeated attempts to secure the depths sought the work was abandoned in 1895 for reasons more fully given in the Report of the Chief of Engineers, United States Army, for that year.

On the lower section of the river, or from its mouth to the forks of the Calumet (this section lies wholly within the State of Illinois), systematic work has been carried on since 1888 up to the close of the fiscal year 1896 to secure a channel 200 feet wide and 16 feet deep, and prior to that date the work had been extended as far as to the One hundred and eighteenth street crossing, a distance of 3¾ miles, with the exception of a short stretch of rock and hardpan involving the future excavation of about 20,000 cubic yards of rock in place, over which stretch the full-depth channel is only 80 feet wide. The work deteriorated rapidly in depth near the upstream limit, and much of it had been dredged the second time.

In view of the rapid increase in size and draft of vessels on the Great Lakes due to the near completion of an enlarged channel between Duluth, Chicago, and Buffalo, and of the impracticability of speedily providing elsewhere at Chicago a channel of sufficient capacity for such large vessels, Congress provided in the river and harbor act of June 3, 1896, that the Calumet River may be dredged to a depth of 20 feet for 2 miles southward from the mouth. The elevators, coal and salt docks, and principal establishments along the river are within this 2-mile limit.

CONDITION OF THE WORK JUNE 30, 1901.

The contract entered into June 8, 1899, for deepening the channel southward from One hundred and sixth street to a depth of 16 feet for a width of 200 feet was completed September 1, 1900. The total amount dredged under the contract was 313,284 cubic yards, costing $50,125.44 at 16 cents the cubic yard, and this improvement now extends to One hundred and eighteenth street, with the exception of a stretch of hardpan and rock near One hundred and twelfth street, requiring blasting and dredging about 20,000 cubic yards if the depth of 16 feet be retained. But as the last river and harbor bill, January 17 and February 19, 1901, indicated the intention of Congress to increase the depth in this stretch to 20 feet as far as One hundred and twenty-second street the rock excavation would be about 65,000 cubic yards, and if the Calumet depth should be made equal to that intended or necessary for Chicago River, about 115,000 cubic yards would be necessary.

Should this work be authorized, it would be most economical to excavate for the maximum channel that eventually will be demanded for the business of the Calumet River. From the cost of work of this class and from inquiry among contractors prepared to undertake it, the price should not exceed $4 the cubic yard, and under a continuing contract might fall below $3.50. The total cost for the increased depth would be $260,000 for 65,000 cubic yards, and $460,000 for 115,000 cubic yards. A thorough survey with borings will be necessary and will be made after the river is frozen over. Examination should be made also over the entire stretch to the forks to ascertain if rock is found to any extent above the probable final bottom of the channel.

This work was not included in the estimate under which operations were authorized, because the existence of rock was unknown at the time and its presence only developed by the dredging.

If the increased depth indicated in the last bill should be authorized, there would be a very large increase in the amount necessary to complete the work. In fact it would seem unwise to enlarge the present project without a full survey of the whole river to a "point about one-half mile above Hammond," to ascertain the class and yardage of the material to be removed.

If there should be no rock, the amount is approximately 3,000,000 cubic yards, and the distance to the dumping ground is so great that the cost may not fall below 25 cents the yard, and perhaps reach 35 cents if the 8-mile limit is used.

With the development of this river the necessity of providing turning basins becomes more pronounced.

Three have been suggested, one eastward of Ninety-fifth street, another about One hundred and fourteenth street, both in old bends of the river cut off in straightening the channel, and the third just below the forks. The first turning basin has been partly finished; but there is a sand island in it that is washing down and shoaling the channel way, and in the meantime is serving as a ship's graveyard. The land is owned by the Calumet Dock Company, and being detached probably could be acquired at a low price.

Should these be approved, it would be economy to undertake the work soon while prices are reasonable. Possibly owners might give the necessary land, but if purchased the cost will not be great. The United States should not be required to construct docks, as in the Chicago River, since none have been built at the suggested sites, and therefore the chief expense would be in dredging. Possibly the work might be undertaken under the existing project, but to avoid doubt legislation is suggested. No special survey or report would be needed, but only the measurements to delimit the lands and ascertain the quantities to be removed. The first turning basin would serve as an excellent winter harbor.

I recommend the removal of the rock near One hundred and twelfth street for the full width of the channel and to a sufficient depth for the maximum channel Congress may authorize, at an estimated cost of $460,000, and under a continuing contract. I also recommend $50,000 for redredging the river to the depth now authorized where found necessary.

The city has begun an important improvement which it is hoped may be extended in the construction of a bascule bridge at Ninety-fifth street under plans approved by the Secretary of War. If possible, all new bridges should be required of this form. The combination of three railway swing bridges which have to be opened on the same signal is exceedingly bad and the cause of much friction and delay to commerce. They should be replaced by a single 6-track bascule bridge under one management.

For details of the work attention is invited to the report of Assistant Engineer G. A. M. Liljencrantz herewith.

PROPOSED APPLICATION OF FUNDS NOW ON HAND AND THOSE ASKED FOR FOR THE FISCAL YEAR ENDING JUNE 30, 1902.

It is proposed to apply these funds to the removal of rock near One hundred and twelfth street for full width of the channel, and to a sufficient depth for the maximum channel Congress may authorize, and to redredging the river to the depth now authorized where found necessary.

Money statement.

July 1, 1900, balance unexpended	$44, 175. 57
June 30, 1901, amount expended during fiscal year	[1]31, 815. 27
July 1, 1901, balance unexpended	12, 360. 30
Amount (estimated) required for completion of existing project	640, 000. 00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	510, 000. 00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

By act of—	
July 5, 1884	$50, 000. 00
August 5, 1886	30, 000. 00
August 11, 1886	50, 000. 00
September 19, 1890	50, 000. 00
July 13, 1892	75, 000. 00
August 18, 1894	45, 000. 00
June 3, 1896	50, 000. 00
By act of—	
March 3, 1899	$60, 000. 00
Total	410, 000. 00
Expended to June 30, 1901	397, 639. 70
Balance unexpended June 30, 1901	12, 360. 30

List of contracts in force during fiscal year ending June 30, 1901, Calumet River, Illinois.

Name and address of contractor.	Nature of contract.	Date.	To expire—	Extended to—	Completed.
Fitzsimons & Connell Co., Chicago, Ill.	Dredging	June 8, 1899	June 30, 1900	Sept. 30, 1900	Sept. 1, 1900

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[1] Includes $1,000 allotted for expenses Office Chief of Engineers for fiscal year 1902.

REPORT OF MR. G. A. M. LILJENCRANTZ, ASSISTANT ENGINEER.

United States Engineer Office,
Chicago, Ill., July 1, 1901.

Major: I have the honor to submit herewith a report on operations in Calumet River, Illinois and Indiana, during the fiscal year ending June 30, 1901.

At the beginning of the year there was one contract in force for the improvement this river, viz, with the Fitz Simons and Connell Company, of Chicago, Ill., dated June 8, 1899, and was for deepening the channel from One hundred and sixth street southward to a depth of 16 feet below Chicago City datum, and for a width of 200 feet.

WORK DONE DURING THE YEAR.

The dredging begun during the previous year was continued under a grant of extension of time for the expiration of the contract, which time had been originally fixed at June 30, 1900. The extension was granted to September 30, 1900. At the close of the year ending June 30, 1900, the channel had been deepened to a point half way between One hundred and fourteenth and One hundred and fifteenth streets. The year's work consisted in the continuation from this point southward until the 29th of August, 1900, when the available funds were practically exhausted and the amount contracted for (312,500 cubic yards), plus 784 cubic yards, had been removed, which brought the improved channel up to One hundred and eighteenth street. The final estimate was submitted on the 1st of September following, and the contract was closed.

TOTAL WORK DONE UNDER THE CONTRACT.

The total work done under the contract was as follows:

	Cubic yards.
Dredging during the year ending June 30, 1900	179,655
Dredging during the year ending June 30, 1901	133,629
Total	313,284

This having been done at the cost of $50,125.44, the contract price being at the rate of 16 cents per cubic yard.

WORK PROPOSED FOR THE YEAR ENDING JUNE 30, 1902.

There being no funds now available, no work is proposed for the improvement of the river at the present time.

The enterprises along this river are constantly increasing and it may be appropriate to make mention of a few of the additions of new elevators, and the increased capacities of others, during the past year, as follows:

1. The South Chicago Elevator Company's elevators "C," "C-Annex," and "D" handled grain between June 30, 1900, and July 27, 1901, as follows:

	Bushels.
Received	19,041,278
Shipped	17,910,655
Total	36,951,933

2. The Rialto Elevator Company is at present erecting a new elevator to be almost entirely of steel and concrete and which is to have a storage capacity of 1,000,000 bushels. They will have facilities for unloading from 100 to 200 cars per day and to load the same into vessels or other cars. It is expected to be in operation in September next.

3. The Calumet Elevator Company's elevator near One hundred and second street, mentioned in last year's report, has handled 30,000,000 bushels, an increase of 6,000,000 bushels over the previous year. Additional facilities are under contemplation to meet the needs of the great increase in their business.

4. The McReynolds Company's elevator "A," at One hundred and sixth street, has a capacity of 1,500,000 bushels, and has facilities for shipping 200,000 bushels of grain and of receiving and elevating 200 cars per day. Their shipments during the past year were as follows:

	By rail.	By water.	Total.
Wheat	295,700	973,700	1,269,400
Corn	2,839,900	2,990,700	5,830,600
Oats	1,217,600	171,400	1,389,000
Barley	140,300		140,300
Totals	4,493,500	4,135,800	8,629,300

5. The J. Rosenbaum Grain Company is erecting an elevator near One hundred and sixth street, at the new Rock Island Railway Company's slip. This elevator will be built entirely of steel and concrete, and will have a capacity of 1,000,000 bushels. It is expected to be ready for operation in the fall of this year.

I am, major, very respectfully, your obedient servant,

G. A. M. LILJENCRANTZ,
Assistant Engineer.

Maj. J. H. WILLARD,
Corps of Engineers, U. S. A.

M M 5.

IMPROVEMENT OF ILLINOIS RIVER, ILLINOIS.

The object of this improvement is to secure ultimately, in connection with an enlargement of the Illinois and Michigan Canal, or an equivalent enlarged canal, a waterway from the southern end of Lake Michigan to the Mississippi River of sufficient capacity for large-sized Mississippi River steamboats, and for military and naval purposes.

The present project was adopted in 1880, and contemplates the extension of the slack-water improvement begun by the State of Illinois from the mouth of Copperas Creek to the Mississippi River at Grafton, Ill., a distance of 135 miles. The project includes the construction of two locks, each 350 feet in length of chamber, 75 feet in width, and with 7 feet depth at low water over sills, and dredging the channel where necessary to secure that depth of water at low water throughout the pools created by the dams.

The locks and dams have been completed and have been in use since 1889 and 1893, respectively. One is situated at Lagrange, 79 miles above the mouth of the Illinois, the other at Kampsville, 31 miles from the Mississippi.

The State of Illinois, aided by the United States, has executed part of the general project by the construction of locks and dams at Hennepin and Copperas Creek, completing, except dredging, that part of the project between La Salle and the mouth of Copperas Creek, a distance of about 90 miles, over which section the State of Illinois collects tolls.

In executing this work the United States has expended prior to June 30, 1897, $1,344,090.62, including $25,000 from appropriation of August 11, 1888, for surveys, and exclusive of $62,359.80 expended upon a foundation for Copperas Creek Lock, afterwards completed by the State of Illinois, and since that date in dredging, care and repair of plant, etc., $86,065.10, making a total expenditure on this work to June 30, 1901, of $1,430,155.72.

The State laws authorizing the construction of the sanitary canal require the removal of the State dams when the flow required by the State law of 20,000 cubic feet per minute for each 100,000 inhabitants of the sanitary district shall have become permanent, the expectation being that the increased discharge would furnish an open navigation equivalent to that pooled by the dams. The discharge of the sanitary canal, however, is regulated by the Secretary of War in so far as it affects the interests of navigation in the Chicago River, and has been reduced by his order to 200,000 cubic feet per minute until the South Branch shall have been widened and deepened sufficiently to permit the full flow required by the State law, or so much thereof as may be found safe.

Unless, therefore, a large amount of dredging is done in the Henry and Copperas Creek State pools, the compensated navigable depth is not likely to be gained, the discharge through the openings in the dams most probably pulling the new water line below present crest heights throughout both pools.

The United States has a general interest in this question because it has spent large sums in extending the navigation of the river, but it has a direct interest in the effect the change must have on the Lagrange pool. This should be surveyed and dredged before the lower State dam is removed; otherwise the navigable length of the Lagrange pool must be shortened.

But if the results should approximate the theories of those advocating the removal of the State dams, Congress would be asked to authorize the removal of the United States dams and thus convert the Illinois into an open river again.

Congress has indicated its purpose to have a thorough survey of the river for a deep waterway, but whether that is done soon or not at all, the War Department should begin collecting information in anticipation of a demand for removing the United States dams. I am not authorized to recommend a survey, but it is not improper to say that precise levels are absolutely necessary to a proper study of the questions that will arise in the near future. A duplicate line between Chicago and the mouth of the Illinois River would require two seasons' work, and would cost $10,000, including instruments, monuments, etc., and would furnish the basis for any future surveys that should be required, whether general or local.

I am of the opinion that an open river with a low-water navigable depth equivalent to that now furnished can not be obtained except by dredging on a large scale with the most approved hydraulic plant. The dredging now in progress is only that necessary to furnish a low-water depth of 7 feet in the pools.

WORK DONE DURING THE FISCAL YEAR ENDING JUNE 30, 1901.

During the year 337,081 cubic yards of material have been dredged and removed from channels, and the plant thoroughly overhauled and put in repair. The barge for machine shop was completed, cabin erected, and all machinery moved into the shop and fitted up for use.

The report of Assistant Engineer C. V. Brainard, giving in detail the work done during the fiscal year ending June 30, 1901, is sent herewith.

PROPOSED APPLICATION OF FUNDS ON HAND AND THOSE ASKED FOR FOR FISCAL YEAR ENDING JUNE 30, 1902.

It is proposed to apply these funds to dredging the channels and to the construction of additional dredging plant.

Money statement.

July 1, 1900, balance unexpended	$59,258.43
June 30, 1901, amount expended during fiscal year	28,040.94
July 1, 1901, balance unexpended	31,217.49
July 1, 1901, outstanding liabilities	3,500.00
July 1, 1901, balance available	27,717.49
Amount (estimated) required for completion of existing project	257,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	257,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

June 30, 1880, available from previous appropriations	$38,337.81
Act of—	
June 14, 1880	110,000.00
March 3, 1881	250,000.00
August 2, 1882	175,000.00
July 5, 1884	100,000.00
August 5, 1886	112,500.00
August 11, 1888	200,000.00
Joint resolution September 29, 1890	200,000.00
Act of—	
July 13, 1892	100,000.00
August 18, 1894	35,000.00
June 3, 1896	40,000.00
March 3, 1899	100,000.00
	1,460,837.81
Received from all other sources	535.40
Total	1,461,373.21
Expended to June 30, 1901	1,430,155.72
Balance unexpended June 30, 1901	31,217.49

Disbursements, fiscal year 1901.

Dredging	$16,204.15
Property and plant	1,184.27
Care and repair of property and plant	5,238.16
Superintendence and office	5,414.36
Total	28,040.94

COMMERCIAL STATISTICS.

Arrival and departure of steamboats at St. Louis, Mo., via Illinois River, calendar year 1900.

Month.	Arrivals.	Departures.	Month.	Arrivals.	Departures.
January	1		August	20	25
February			September	23	19
March	5	8	October	21	19
April	15	14	November	20	17
May	19	21	December	3	
June	21	20			
July	21	21	Total	169	164

	Tons.
Receipts	20,905
Shipments	5,020

REPORT OF MR. C. V. BRAINARD, ASSISTANT ENGINEER.

KAMPSVILLE, ILL., *July 6, 1901.*

MAJOR: I have the honor to submit the following report of operations upon the Illinois River for the fiscal year ending June 30, 1901. The work has consisted mainly of dredging the bars from Kampsville lock to the mouth of the river, and care and repair of plant. A survey was made and platted of the river between Hardin and the head of Diamond Island, a distance of 4.4 miles.

In June a trip was made from the mouth to Copperas Creek lock, and all the snags removed. The flow of the water through the Chicago Sanitary Canal has apparently materially increased the low stages on this river. Last summer, though very dry, at Copperas Creek lock the lowest stage was about 3.8 feet, at Lagrange lock 4 feet, and at Kampsville lock 3.2 feet above low water.

DREDGING.

Six-mile Island bar, 22 miles to 23.7 miles below Kampsville lock.—Work was in progress here at the beginning of the fiscal year and was continued until the work of widening the channel to 150 feet was accomplished. On May 25 work was resumed, and the channel widened to 200 feet. Eighty-five thousand two hundred and ninety-four cubic yards of material was removed during the year, making a total of 112,294 cubic yards removed from this bar.

Twelve-mile Island bar (lower), 17.7 miles to 18.5 miles below Kampsville lock.—In 1900 the channel here was widened to 150 feet, and in June, 1901, to 200 feet, 31,787 cubic yards of material being removed.

Between McDonald's landing and the mouth of Otter Creek, 15.2 miles to 16.4 miles below Kampsville lock.—The channel between these points was widened to 200 feet, 15,833 cubic yards of material being removed.

Between Guilford and McDonald's landings, 13.9 miles to 15.2 miles below Kampsville lock.—The channel between these points was widened to 200 feet, 69,859 cubic yards of material being removed.

Between mouth of Macoupin Creek and Guilford landing, 12.6 miles to 13.9 miles below Kampsville lock.—The channel here was widened to 150 feet in 1900, and June 27 work was begun widening it to 200 feet, and at date of this report work is still in progress, there being 29,084 cubic yards of material already removed.

French bar, 11 miles to 12.6 miles below Kampsville lock.—A dike at the upper end of the lower crossing through this bar was removed and the upper crossing widened out to 200 feet, in all 7,633 cubic yards of material being removed.

Between Hardin and French bar, 9.9 miles to 11 miles below Kampsville lock.—The channel between these points was widened to 150 feet where narrower, 2,713 cubic yards of material being removed.

Between the foot of Diamond Island and Hardin, 8.2 miles to 9.9 miles below Kampsville lock.—Where the channel was narrower than 150 feet it was dredged to that width, 8,901 cubic yards of material being removed.

Hurricane Island bar, 3 miles to 5 miles below Kampsville lock.—Dredging was resumed here October 3, 1900, the channel along the island being widened to 175 feet and the upper crossing to 200 feet; 85,977 cubic yards of material was removed during the year, making a total of 166,417 cubic yards removed from this bar.

CARE AND REPAIR OF PROPERTY AND PLANT.

Dredge Apache.—Repaired boiler, putting three patches on the sides of the fire box and one patch three-fourths way around fire-box door, put in 29 new stay bolts, calked around stern and starboard spuds, repaired crossheads of main engines, repaired spud hoist drums, strengthened backing drum, riveted dipper, had copper coil of heater repaired in St. Louis, repaired and strengthened A frame, fitted up and put in new set of dipper handles, calked deck, renewed spud hoist chains, renewed roof, and painted cabin inside and out.

Dredge No. 1.—Repaired nosing, riveted dipper, renewed roof, hoisting and backing chains, rotten plank in deck, and purchase sheave on crane, strengthened swinging-engine bed and crown-wheel supports, put in new stern spud, and painted cabin inside and out.

Dredge No. 2.—Repaired boiler, putting two patches each 14 by 44 inches on the sides of the fire box, and one patch 28 by 32 inches around the fire-box door, put in 113 new stay bolts, repaired heater, swinging engine and driver, crown wheel, repaired, riveted and tightened truss, repaired and renewed bottom fastenings of hogchains, riveted dipper, expanded flues, refitted main steam pipes, overhauled and strengthened crane, renewed crank shaft of swinging engine, male friction of backing drum and roof, put in one new spud, and painted cabin inside and out.

Steamer Pearl.—Hauled out on ways, calked and painted hull, repaired bow, stem, nosing, wheel and deck; overhauled and repaired scow and feed pumps, renewed one rudder, renewed roof, rebuilt furnace walls, re-covered boilers, cut two hatches for hull ventilators in forward end of cabin and painted cabin inside and out.

Steamer Marion.—Hauled out on ways, calked and painted hull, repaired bow stem, supply pipes to well, head block and towing knee and wheel; cut rotten plank out of gunwales and put in six patches, renewed bad parts of forward deck, put on new roof, cut two hatches for ventilators in forward end of cabin, and painted cabin inside and out.

Steamer Fox.—Hauled out on ways, scraped, calked, and painted hull, repaired deck, repaired and painted roof and wheel, re-covered boiler, cut two hatches for hull ventilators in forward end of cabin, and painted cabin inside and out.

Launch W. M. Childs.—Hauled out, calked, and painted hull, and overhauled and repaired motor and pump.

Office boat.—Replaced canvas roof with one of prepared paper and painted cabin inside and out.

Quarter boat No. 1.—Hauled out on ways, repaired and calked hull, renewed roof, and renewed deck at ends of cabin.

Quarter boat No. 2.—Hauled out on ways, replaced rotten plank in rakes with new, renewed corner rake timbers and nosing, calked and painted cabin inside and out.

Pile-driver engine No. 2.—Unloaded engine and boiler off barge onto bank and painted them.

Machine-shop engine.—Moved small boiler and engine from grounds onto new machine-shop barge, set up on blocks inside shop, repaired fire box and boiler, and fitted up engine to run.

Worthington pump.—Overhauled and fitted up for use, renewing piston and head in water end.

Eight-inch centrifugal pump.—Repaired and fitted up ready for use.

Barge No. 1.—Moved engine onto bank, transferred forge, lathe and all tools and material into new shop, and demolished cabin.

Barge No. 2.—Hauled out on ways and calked knuckle seam.

Scows 3, 4, 5, and 6.—Hauled out and rebuilt by renewing pocket and end decking, rafters, pocket and end deck timbers, collar beams, rake timbers and planking, pockets corner posts, new doors, gunwale strakes, strengthened bulkhead and repaired ironwork.

Scow No. 7.—Repaired nosing, made new stirrups, two new door hinges and hung three new doors.

Scow No. 8.—Hauled out, repaired pocket decking, hung one new and rehung two old doors and renewed nosing.

Scow No. 9.—Renewed nosing.

Scow No. 10.—Repaired deck, sheave irons, and renewed nosing.

PLANT.

Machine shop.—Finished building 18 by 80 foot barge, and put on cabin 18 by 60 feet. Made and fitted up workbenches, boxes for bolts, washers, etc., and rack for holding various sizes of bar iron; moved engine, forge, lathe, shearing and punching machines, thread cutter, wood saw, emery wheels, grindstone, etc., into shop, and fitted up same for use.

Very respectfully, your obedient servant,

C. V. BRAINARD,
Assistant Engineer.

Maj. J. H. WILLARD,
Corps of Engineers, U. S. A.

M M 6.

OPERATING AND CARE OF LAGRANGE AND KAMPSVILLE LOCKS, ILLINOIS RIVER AND APPROACHES THERETO.

These locks and dams have been operated and maintained under the indefinite appropriation provided for in section 4 of the river and harbor act of July 5, 1884.

Lagrange lock and dam.—The works were operated and cared for by hired labor during the year. The ironwork on the lock walls and gates was painted; two small flatboats rebuilt; ice house raised, new foundations put under it, and sufficient ice harvested to fill it. The shop was raised above high water by constructing a mound of dirt previously thrown out by the dredges and placing the shop upon it. Outbuildings, grounds, etc., kept in good order.

During the period between December 18 and March 11 there was no navigation through the lock, except four steamboats in January. March 17 to April 29, during high water, all boats passed over the dam except a few heavily loaded barges and small steamers.

The tonnage for fiscal year shows an increase over that for preceding year, ranking fifth in amount since the lock has been in operation, about twelve years. Five thousand three hundred and sixteen dollars and seventy-four cents was expended during the year, exclusive of $402.90, outstanding June 30.

Kampsville lock and dam.—The lock and dam were operated and cared for during the year by hired labor. All buildings and ironwork on lock walls were painted; riprapped levee; the spar tracks were raised, leveled, ballasted, and ties renewed.

Between December 16 and March 15 there was no navigation through the lock, and from March 24 to April 28, with the exception of three ice tows and one small steamer, all boats passed over the dam.

Tonnage of steamboats is greater than that of any year since the works have been in operation, and the combined tonnage of steamboats and barges ranks fifth.

The expenditures during the year amounted to $5,338.23, exclusive of $471.97, outstanding liabilities June 30.

Accompanying report of Assistant Engineer C. V. Brainard, which is herewith, are tables showing number of boats navigating the river, number of times they have passed through the locks, and traffic at each lock since they were opened to navigation.

Summarized statement of expenses from appropriation for operating and care of canals and other works of navigation, indefinite, applied to Lagrange and Kampsville locks, Illinois River.

Lagrange lock:		
Services	$5,200.26	
Traveling expenses	15.50	
Materials	38.40	
Supplies	62.58	
Total		$5,316.74
Kampsville lock:		
Services	5,118.80	
Traveling expenses	20.24	
Materials	168.86	
Supplies	24.33	
Job printing	2.40	
Freight charges	3.60	
Total		5,338.23
		10,654.97

Money statements.

LAGRANGE LOCK.

July 1, 1900, balance unexpended (outstanding)	$450.98
July 1, 1900, allotment for fiscal year 1901	10,000.00
June 30, 1901, amount expended during fiscal year	5,316.74
July 1, 1901, balance unexpended	5,134.24
July 1, 1901, outstanding liabilities	402.90
July 1, 1901, balance available	4,731.34

KAMPSVILLE LOCK.

July 1, 1900, balance unexpended (outstanding)	$422.44
July 1, 1900, allotment for fiscal year	10,000 00
June 30, 1901, amount expended during fiscal year	5,338.23
July 1, 1901, balance unexpended	5,084.21
July 1, 1901, outstanding liabilities	471.97
July 1, 1901, balance available	4,612.24

REPORT OF MR. C. V. BRAINARD, ASSISTANT ENGINEER.

KAMPSVILLE, ILL., *July 6, 1901.*

MAJOR: I have the honor to submit the following report of operating and care of locks and dams, Illinois River, for the fiscal year ending June 30, 1901:

LAGRANGE LOCK.

There was no navigation through this lock between December 18 and March 11, except four steamboats in January. From March 17 until April 29 all boats passed over the dam, except a few heavily loaded barges, and small steamers which did not have the power to take them over the dam.

This lock has been in operation nearly twelve years, and the fiscal year ending June 30, 1901, ranks fifth in amount of tonnage passing through. Nearly all classes of freight show a slight increase over the average of former years, which is probably due to the success of crops in the district tributary to the lock.

The grounds, fences, sidewalks, and outbuildings were kept in good order; the ice house was raised and a new foundation put under it; a mound was built of dirt previously thrown out by the dredges and the shop was moved from the low ground onto this; a stone wall was built around the cellar entrance of the overseer's house, and frames and doors made for this entrance; the ironwork on the lock walls and gates was painted; two small flatboats were rebuilt; 100 tons of ice was harvested, filling the ice house.

KAMPSVILLE LOCK.

There was no navigation through this lock between December 16 and March 14. From March 24 until April 28 all boats passed over the dam except three heavily loaded ice tows and one small steamer which did not have power enough to take it over the dam.

This lock has been in operation nearly eight years. The tonnage of steamboats passing the present year is greater than any previous year, but in combined tonnage of steamboats and barges it ranks fifth. The different classes of freight as a whole show a slight increase over the average of former years, though some show a decrease. This is doubtless due to the success of crops along the river.

A garden was made and tended for the use of the dredging crews; both dwellings, the lock hands' quarters, office, watchhouse, and ironwork on lock walls were painted; varnished woodwork inside of houses 1 and 2; papered kitchen of house No. 1 and three rooms of house No. 2; made two storm doors for each dwelling; riprapped levee running out from east abutment of dam; renewed ties, raised, leveled and ballasted spar tracks, and kept sidewalks and outbuildings in good repair.

TONNAGE.

There are herewith tables showing traffic by each lock since they were opened to navigation, also a table showing boats navigating the river and the number of times each passed the locks.

Very respectfully, your obedient servant,

C. V. Brainard,
Assistant Engineer.

Maj. J. H. Willard,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Tonnage passing Lagrange lock.

	Fiscal year ending June 30—					
	1890.	1891.	1892.	1893.	1894.	1895.
Steamboats ....number..	142	280	265	291	296	374
Barges..............................do....	68	147	168	176	213	251
Steamboats.....................tonnage..	41,915	63,967	68,236	80,131	59,730	60,814
Barges..............................do....	12,386	45,711	79,211	162,118	91,361	76,530
Ice..................................tons..	(*a*)	20,575	39,400	46,600	31,900	11,950
Wheat..........................bushels..	5,082	9,800	14,536	12,700	6,750	22,071
Corn................................do....	(*a*)	18,176	83,800	29,691	45,900	87,563
Passengers......................number..	(*a*)	(*a*)	1,334	2,382	2,179	4,682
General merchandise ....tons..	(*a*)	(*a*)	1,651	4,675	3,733	1,976
Coal................................do....	100	650	729	225	1,087	640
Stock ....head..	(*a*)	(*a*)	219	298	2,307	1,323
Wood..............................cords..	....	70	250	250	60	28
Logs and lumber ....Feet B. M..	....	45,000	10,000	196,000	250,000	....

	Fiscal year ending June 30—					
	1896.	1897.	1898.	1899.	1900.	1901.
Steamboats ....number..	340	416	420	412	393	511
Barges..............................do....	164	224	235	211	170	225
Steamboats.....................tonnage..	79,495	91,550	90,780	100,363	96,937	107,599
Barges..............................do....	49,802	76,091	80,925	85,668	35,461	55,149
Ice..................................tons..	11,150	19,425	11,975	18,400	3,300	9,000
Wheat..........................bushels..	30,142	21,477	6,850	12,665	29,455	53,642
Corn................................do....	67,179	161,767	187,500	136,029	63,940	202,977
Passengers ....number..	6,391	4,774	10,300	18,764	7,996	12,387
General merchandise..............tons..	6,455	4,508	3,134	4,981	1,670	2,178
Coal................................do....	80	320	395	654	3,132	1,895
Stock ....head..	1,925	1,657	2,516	1,788	1,429	2,286
Wood..............................cords..	....	335	900	....	....	....
Logs and lumber ....feet B. M..	10,000	140,000	43,500	115,000	10,000	379,500
Apples..........................barrels..	9,670	158	2,352	577	7,638	315

a No record kept.

Tonnage passing Kampsville lock.

	Fiscal year ending June 30—							
	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.
Steamboats ....number..	177	440	436	320	328	311	401	387
Barges...................do....	220	192	156	106	100	84	119	104
Steamboats..........tonnage..	57,149	99,315	111,382	107,855	124,253	121,741	126,708	126,922
Barges...................do....	51,295	81,597	54,304	66,769	66,718	56,315	28,428	40,028
Ice.......................tons..	31,900	11,950	10,950	19,425	11,925	18,400	3,300	9,000
Wheat................bushels..	63,600	178,025	158,795	130,081	39,719	58,016	61,411	89,360
Corn.....................do....	86,267	164,000	178,188	72,047	63,367	35,421	5,285	36,781
Other grain ....do....	....	1,284	2,567	1,873	5,426	4,138	2,600	7,057
Apples................barrels..	....	2,359	6,396	1,231	5,618	828	9,531	1,418
General merchandise...tons..	4,692	3,454	8,169	7,899	5,960	6,593	3,880	5,112
Passengers...........number..	1,197	5,017	7,049	4,796	5,670	6,593	9,737	14,683
Stock ....head..	1,197	8,735	12,358	14,603	14,472	21,642	19,796	23,055
Logs and lumber..feet B. M ..	....	....	....	30,000	85,000	16,000	100,000	119,590
Ties..................number..	....	....	....	....	....	4,600	9,200	23,424
Brush...........cubic yards..	....	....	....	....	....	800	9,550	....

List of steamboats navigating the Illinois River during the fiscal year ending June 30, 1901.

Name.	Registered tonnage.	Number of lockages.	
		Lagrange.	Kampsville.
Bald Eagle	590	144	146
R. C. Gunter	288	....	92
Belle of Ottawa	11	46	4
H. W. Longfellow	47	35	22
R. G. Schmoldt	19	34	....
Reindeer	130	81	5
Lee	86	30	....
G. M. Sively	98	23	11
Little Dick	4	20	2
City of Peoria	128	16	8
Polar Wave	150	12	12
R. E. Cole	4	12	....
Edith K	23	11	....
New Haven	80	....	10
Golden Gate	142	3	9
Bimini	4	8	2
Spread Eagle	691	2	6
Jack Frost	850	6	6
C. W. Kinnear	4	6	....
Illini	3	6	2
Myrtle	8	6	....
Lilly	507	4	4
Niagara	91	4	....
Virginia	5	....	4
Grey Eagle	555	2	3
City of Sheffield	700	....	2
Jacob Richtman	327	....	2
Flying Eagle	142	....	2
Imperial	95	2	2
Wanderer	89	2	2
Little Clyde	78	2	2
Juliet	44	2	2
Dunbar	22	2	....
Vailima	16	2	2
Lola	13	2	2
Hebe	11	2	....
Genevieve	10	....	2
Leona	10	....	2
Lillian	8	2	2
Pirl	8	2	....
Kid	6	2	....
City of Pekin	5	2	....
Actea	4	2	....
Galatea	4	2	....
Dorothy	8	2	....
Verne Swain	134	1	1
Fred Swain	124	1	1
Anderson	41	1	1
Elizabeth Hyde	89	1	1
Minnie B	30	1	1
Lady Jane	21	1	1
Gypsy	17	1	1
Druid	15	1	1
Viviane	11	1	1
Viviane No. 3	11	1	1
Gazel	9	1	1
Lulu G	8	1	1
Hornet	7	1	1
Charles Edmund	6	1	1
Cruiser	4	1	....
Diamond	4	1	1
Lena	4	1	....
Ethel	3	1	....

M M 7.

CONSTRUCTION OF ILLINOIS AND MISSISSIPPI CANAL.

The object of this improvement is to furnish a navigable waterway from Lake Michigan at or near Chicago, Ill., to the Mississippi River at the mouth of Rock River, near Rock Island, Ill., in connection with the Upper Illinois River and the proposed enlarged waterway along the present line of the Illinois and Michigan Canal.

Various surveys of different routes from the great bend of the Illinois near Hennepin, Ill., to the Mississippi River at or above the mouth of Rock River have been made, viz: In 1871 (Report of the Chief of Engineers, 1871, p. 303), in 1882 (Report of the Chief of Engineers, 1883, p. 1757), and in 1885 (Report of the Chief of Engineers, 1886, p. 1707).

There was also a report upon the canal by a Board of Engineers in 1887, under the provisions of the river and harbor act of August, 1886 (Report of the Chief of Engineers, 1887, p. 2145).

After much discussion the present or Rock Island route was adopted.

Detailed plans and estimates, based upon preliminary surveys and under the river and harbor act of August 11, 1888, were prepared in this office and submitted to Congress June 21, 1890, the report of which plans and estimates was published as House Ex. Doc. No. 316, Fifty-first Congress, first session. This report was the basis of subsequent appropriations.

The plans submitted in 1890 were subsequently modified (Reports of the Chief of Engineers, 1891, 1892, 1896), and contemplate the construction of a canal at least 80 feet wide at the water surface, 7 feet deep, with locks 170 feet long between quoins, 35 feet wide; admitting barges carrying 600 short tons of freight if we allow 240 short tons for weight of vessels, and 140 feet length, 34 feet beam, and 6 feet draft of vessel that may easily navigate the canal.

The canal to begin at the great bend of the Illinois River; thence, via the valleys of Bureau, Pond, and Cowcatcher creeks, to the summit level near the eighteenth mile, ascending 196 feet through 21 locks, with lifts varying from 7 to 11 feet each; thence to the feeder junction, near the twenty-eighth mile; thence to Rock River, just above the mouth of Green River; thence down Rock River to its mouth. The length of the canal is about 75 miles, having been shortened about 2 miles by the adoption of the Green River route instead of the Penney Slough route. The descent from the summit level to the low-water level of the Mississippi River is 93 feet, effected by 10 lift locks, from 6 to 14 feet lift, with one guard lock. The number of lift locks has been reduced from 37 to 31, and the summit level has been cut down 9 feet in the changes since the 1890 report by subsequent surveys, and the length of the main line of the canal has been reduced from 77 to 75 miles.

The feeder as now located is 29 miles in length, instead of 34¾ miles, as proposed in 1890, and 37½ miles, as proposed in 1871 and in 1883.

The entire line of the canal and feeder has been definitely located by authority of the Secretary of War, as required by river and harbor act of August 11, 1888, and subsequent acts of Congress.

A more extended study of the line through Cecil's slough, together with experiments on slopes and revetment of the peat bog, led to a revision of the opinion that this line should be abandoned for that known as line F.

A board of engineers appointed from assistants on the canal made a very thorough examination and a favorable report, which was subsequently confirmed by a Board of Engineer officers and approved by the Department.

The failing contractors having been settled with upon terms approved by the Secretary of War, the work may now be carried through under new specifications either by contract or by hired labor.

The location of lock near Colona has been changed to a point eastward, thus simplifying the crossings of the two railways at that point, and probably reducing the cost of construction.

The change was especially agreeable to the railway companies for although the cost would have been borne by the United States, there would have been much delay to the traffic during construction.

The question of spillways or gates at the Green River aqueduct is still under study, it being very important to draw down the feeder or the summit level in case of accident.

The design for the movable dam at the head of the feeder, required by decree of court, has been worked out and submitted to the Chief of Engineers. This is a combination of overhead bridge with Boulé gates and suspended frames. The maneuvers are to be made by means of differential pulleys, running on trolleys on the top chords on each side. The design has been submitted to a Board of Engineers for report.

The question of locking into the Sterling pool has not been settled, and it is understood will be revived in the next Congress. The estimate of $75,000 should be provided, in addition to that for the canal and feeder.

The Moline highway bridge, costing $25,000, was ordered to be built out of the canal appropriation, although it was not estimated for, the expectation being that the city of Moline would be required to build the bridge.

There have been great economies in constructions, but the cost of right of way and damages, the demands for highway bridges, not only larger than those proposed, but larger than those planned for the new barge canal in the State of New York, the necessity of providing larger and lower culverts, with flushing devices, owing to the development of the drainage districts, and finally the imperative need of revetting a great portion of the banks, can not fail to increase the final cost of the canal considerably above the original estimate of $6,925,960, as given in the report of 1890.

* * * * * * *

CONDITION OF THE WORK JUNE 30, 1901.

Work began under the conditions imposed by the river and harbor act of September 19, 1890, upon the Rock River end of the canal in 1892, by the construction of a canal around the lower rapids of Rock River, 4½ miles long, with 3 locks, 3 swing bridges, 2 dams, 3 lock houses, 7 sluiceways, and 1 arch culvert, which canal was opened to navigation April 17, 1895, and has since that date been in successful operation. The Moline wagon bridge across Rock River has been built.

At the date of this report the earthwork of 18 miles of the eastern section, except part of mile 1, forming the approach from the Illinois River to Lock No. 1, has been completed. Some reenforcement of high embankments and lining the canal trunk where required with water-tight material remain to be done. Earthwork on mile 19 is about 95 per cent complete. No earthwork has been done on miles 20 to 23, inclusive; on miles 24 and 25 earthwork is in progress by hired labor, and is about 55 per cent complete. Earthwork on miles 26 to 28, inclusive, is more than 90 per cent complete. Ten highway bridges have been completed; 1 single-track and 2 double-track railroad bridges have been built; 3 aqueduct bridges have been completed. Twenty-one locks of concrete masonry have been completed except gates, valves, and fixtures. Nine arch culverts are complete with exception of flushing arrangements for 2; 11 pipe culverts have been completed and 2 others are in course of construction. The necessary warehouses and houses to shelter locomotives have been built; 3 superintendents' houses, 1 each on mile 2, mile 11, and mile 17; 2 lock-keepers' houses, 1 on mile 7, the other on mile 13, and a small 4-room house on mile 24 for office use have been built. A construction railway of 3-foot gauge is located along the canal from mile 2 to 17, with sufficient side tracks to connect with storage yards and work under construction. Three locomotives are in use handling material and earthwork in reenforcing high embankments.

On the feeder 4,405,566 cubic yards of earthwork have been excavated, of which 1,145,964 cubic yards were done during the fiscal year. Ten pipe culverts and the foundation for 6 arch culverts have been completed, and the foundation for another arch culvert completed, with the exception of slope paving. The concrete masonry for 3 arch culverts and flushing devices for 2 pipe culverts were built. One double 12-foot arch culvert has been completed. Foundations and abutments for 7 highway bridges have been built and the vertical retaining wall and slope paving completed for 5. The superstructure of one double-track highway bridge and one double-track railroad bridge was completed. Work on highway bridges was stopped with the completion of the masonry on account of writs of injunction issued by the circuit court of Whiteside County, Ill., at the instance of highway commissioners. Four of the writs have been dismissed in the United States court, but one still remains in force. These injunctions covered practically all the bridges on the first 16 miles of the feeder. Ten miles of railway track material was purchased and about 3 miles of track has been laid. It became necessary to condemn a small amount of additional land for obtaining material for highway bridge approaches and ground on which to build approaches. This land was condemned on May 7, 1901, but the decree in the case has not yet been filed.

All of the right of way on the western section, including the lands to be damaged by overflow, has been condemned and all paid for except 3 tracts, titles to which were found defective by the Attorney-General and have not yet been cleared. About 21 miles of earthwork have been placed under contract and 1,712,512 cubic yards excavated, of which 1,297,739 were done during the fiscal year. The foundations for 3 arch culverts have been built and excavation for the fourth is in progress. Thirteen pipe culverts are entirely completed and construction of the fourteenth in progress. About 32 miles of fencing have been built. Warehouses were built at Lock 22, Sheffield, Annawan, Atkinson, and Geneseo.

For detailed statement of work done during the year see accompanying reports of Assistant Engineers Long and Wheeler, who have been in local charge of the works.

Money statement.

July 1, 1900, balance unexpended	$1,719,728.60
Amount appropriated by sundry civil act approved March 3, 1901	975,000.00
	2,694,728.60
June 30, 1901, amount expended during fiscal year	971,707.35
July 1, 1901, balance unexpended	1,723,021.25
July 1, 1901, outstanding liabilities	95,335.21
July 1, 1901, balance available	1,627,686.04
July 1, 1901, amount covered by uncompleted contracts	175,021.50
Amount (estimated) required for completion of existing project	758,220.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	758,220.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

July 1, 1890, balance unexpended from previous appropriations	$786.46
Act of—	
September 19, 1890	500,000.00
July 13, 1892	500,000.00
August 17, 1894	190,000.00
June 3, 1896	45,000.00
Sundry civil act June 4, 1897	875,000.00
Sundry civil act, July 1, 1898	1,427,740.00
Sundry civil act, March 3, 1899	700,000.00
Sundry civil act, June 6, 1900	1,000,000.00
Sundry civil act, March 3, 1901	975,000.00
Total	6,213,526.46
Expended to June 30, 1901	4,490,505.21
Balance unexpended July 1, 1901	1,723,021.25

ILLINOIS AND MISSISSIPPI CANAL—WESTERN SECTION.

Around lower rapids of Rock River—Total cost.

[4½ miles completed and in operation.]

Surveys	$22,938.92
Right of way	26,851.14
Canal trunk:	
Mile 1	24,154.91
Mile 2	18,985.64
Mile 3	18,680.01
Miles 4 and 5	126,716.52

Lock No. 37	89, 542. 31
Lock No. 36	39, 532. 19
Guard Lock	72, 696. 97
Dams	35, 086. 13
Bridges	39, 437. 89
Property	32, 607. 30
Total	547, 229. 93

Rock River division—Cost to close of fiscal year 1901.

Dredging Rock River	$470. 21
Moline highway bridge	25, 000. 00
Total	25, 470. 21

Feeder Junction to Rock River, annual statement fiscal year 1901.

Right of way	$26, 045. 35
Canal trunk:	
Mile 28	1, 991. 23
Mile 29	2, 659. 93
Mile 30	507. 41
Mile 31	226. 66
Mile 32	505. 09
Mile 33	5, 629. 44
Mile 34	4, 923. 39
Mile 35	4, 366. 30
Mile 36	774. 31
Mile 37	7, 339. 03
Mile 38	25, 132. 36
Mile 39	6, 369. 49
Mile 40	14, 722. 50
Mile 41	6, 406. 95
Mile 42	9, 529. 37
Mile 43	6, 873. 35
Mile 44	6, 449. 53
Mile 45	10, 221. 07
Mile 46	15, 758. 32
Mile 47	5, 643. 76
Mile 48	12, 892. 01
Mile 49	699. 49
Mile 50	655. 03
Mile 51	673. 50
Mile 52	659. 35
Mile 53	13. 44
Culverts:	
No. 18	1, 383. 05
No. 19	2, 754. 56
No. 20	2, 668. 88
No. 21	564. 87
No. 22	3, 506. 64
No. 23	5, 234. 07
No. 24	3, 000. 66
No. 25	3, 341. 12
No. 26	4, 868. 49
No. 27	4, 789. 29
Culverts—Continued.	
No. 28	$1, 727. 34
No. 29	3, 167. 64
No. 30	1, 183. 71
No. 31	4, 430. 71
No. 32	2, 995. 18
No. 33	3, 322. 75
No. 34	2, 994. 25
No. 35	34. 28
No. 36	68. 67
Highway bridges:	
No. 17	2, 102. 87
No. 18	1, 671. 58
No. 19	335. 78
No. 21	247. 38
No. 22	210. 00
No. 23	31. 66
No. 24	250. 02
No. 25	1, 591. 47
No. 26	741. 30
No. 27	944. 25
No. 28	2, 749. 39
No. 29	1, 474. 09
No. 30	1, 653. 40
No. 31	727. 27
No. 32	1, 246. 76
No. 34	1, 575. 33
No. 35	272. 88
No. 37	50. 00
No. 38	200. 00
Lock No. 22	9. 50
General construction	1, 969. 92
Superintendence and office	6, 669. 61
Care and repair of property and plant	85. 79
Property	3, 267. 09
Material (stock on hand)	4, 870. 69
Total for fiscal year 1901	264, 651. 85

Feeder junction to Rock River, cost to close of fiscal year 1901.

	At close of 1900.	Fiscal year 1901.	Equitable part of general construction, superintendence and office, care and repair of property, and deterioration of property.	Total.
Surveys	$19,764.09			$19,764.09
Right of way	138,456.31	$26,045.35		164,501.66
Canal trunk:				
Mile 28	1,150.21	1,991.23	$83.44	3,224.88
Mile 29	8,300.62	2,659.93	111.48	11,072.03
Mile 30	128.02	507.41	21.27	656.70
Mile 31	21.74	226.66	9.51	257.91
Mile 32	142.28	505.09	21.16	668.53
Mile 33	120.51	5,629.44	235.93	5,985.88
Mile 34	172.88	4,923.39	206.34	5,302.61
Mile 35	131.96	4,366.30	182.98	4,681.24
Mile 36	115.83	774.31	32.45	922.59
Mile 37	138.36	7,339.03	307.58	7,784.97
Mile 38	129.19	25,132.36	1,053.29	26,314.84
Mile 39	848.04	6,369.49	266.94	7,484.47
Mile 40	917.33	14,722.50	617.02	16,256.85
Mile 41	919.24	6,406.95	268.52	7,594.71
Mile 42	912.86	9,529.37	399.37	10,841.60
Mile 43	905.18	6,873.35	288.06	8,066.59
Mile 44	3,235.46	6,449.53	270.30	9,955.29
Mile 45	2,404.34	10,221.07	428.36	13,053.77
Mile 46	952.78	15,758.32	660.42	17,371.52
Mile 47	989.68	5,643.76	236.54	6,869.98
Mile 48	4,452.76	12,892.01	540.30	17,885.07
Mile 49	108.55	699.49	29.31	837.35
Mile 50		655.03	27.45	682.48
Mile 51		673.50	28.22	701.72
Mile 52		659.35	27.62	686.97
Mile 53		13.44		13.44
Culverts:				
No. 18	900.57	1,383.05	57.96	2,341.58
No. 19	6.30	2,754.56	115.44	2,876.30
No. 20	6.30	2,668.88	111.86	2,787.04
No. 21	11.25	564.87	23.68	599.80
No. 22	6.30	3,506.64	146.96	3,659.90
No. 23	6.30	5,234.07	219.35	5,459.72
No. 24	11.25	3,000.66	125.77	3,137.68
No. 25	6.30	3,341.12	140.02	3,487.44
No. 26	6.30	4,868.49	204.04	5,078.83
No. 27	6.30	4,789.29	200.70	4,996.29
No. 28	450.55	1,727.34	72.38	2,250.27
No. 29	6.30	3,167.64	132.76	3,306.70
No. 30	11.25	1,183.71	49.62	1,244.58
No. 31	6.30	4,430.71	185.70	4,622.71
No. 32	6.30	2,995.18	125.52	3,127.00
No. 33	6.30	3,322.75	139.26	3,468.31
No. 34	6.30	2,994.25	125.48	3,126.03
No. 35		34.28		34.28
No. 36		68.67		68.67
Highway bridges:				
No. 17	456.07	2,102.87	88.13	2,647.07
No. 18		1,671.58	70.05	1,741.63
No. 19		335.78	14.08	349.86
No. 21		247.38	10.35	257.73
No. 22		210.00	8.80	218.80
No. 23		31.66		31.66
No. 24		250.02	10.48	260.50
No. 25		1,591.47	66.70	1,658.17
No. 26		741.30	31.05	772.35
No. 27	631.85	944.25	39.56	1,615.66
No. 28	84.80	2,749.39	115.21	2,949.40
No. 29	617.14	1,474.09	61.77	2,153.00
No. 30	589.52	1,653.40	69.30	2,312.22
No. 31		727.27	30.47	757.74
No. 32	424.86	1,246.76	52.26	1,723.88
No. 34		1,575.33	66.01	1,641.34
No. 35		272.88	11.44	284.32
No. 37		50.00		50.00
No. 38		200.00		200.00
Lock No. 22	385.15	9.50		394.65
House at Lock No. 22	2,179.98			2,179.98
General construction		1,969.92		
Superintendence and office		6,669.61		
Care and repair of property and plant		85.79		
Property	37.11	3,267.09		2,758.50
Material (stock on hand)		4,870.69		4,870.69
Total	192,285.17	264,651.85	9,276.02	456,987.02

ILLINOIS AND MISSISSIPPI CANAL-FEEDER LINE.

Annual statement, fiscal year 1901.

Right of way	$93.76
Right of flowage	26,191.22
Feeder trunk:	
Mile 1	2,202.27
Mile 2	168.58
Mile 3	9,468.01
Mile 4	1,817.48
Mile 5	183.43
Mile 6	170.00
Mile 7	150.00
Mile 8	154.50
Mile 9	7,873.12
Mile 10	250.66
Mile 11	688.02
Mile 12	10,193.64
Mile 13	22,326.14
Mile 14	13,495.04
Mile 15	2,183.51
Mile 16	748.00
Mile 17	10,347.03
Mile 18	1,491.72
Mile 19	94.78
Mile 20	120.23
Mile 21	8,016.83
Mile 22	22,700.42
Mile 23	11,682.11
Mile 24	22,747.05
Mile 25	15,604.90
Mile 26	23,296.41
Mile 27	1,350.60
Mile 28	2,472.40
Mile 29	5,732.84
Culverts:	
No. 1	500.47
No. 2	480.60
No. 3	2,869.29
No. 4	3,168.50
No. 5	5,303.21
No. 6	8,683.14
No. 7	4,325.76
No. 8	9,854.14
No. 9	10,003.42
No. 10	3,108.13
No. 11A	4,615.95
Culverts—Continued.	
No. 11B	$213.32
No. 12	2,648.18
No. 13	2,685.81
No. 14	2,144.85
No. 15	414.00
No. 16	944.21
No. 17	13,578.09
Highway bridges:	
No. 44	317.01
No. 45	2,738.39
No. 46	1,082.11
No. 47	1,560.12
No. 48	3,685.64
No. 49	5,422.74
No. 50	4,742.21
No. 51	748.55
No. 52	525.38
No. 53	30.63
No. 55	1,201.28
No. 56	142.65
No. 59	3,202.69
No. 60	3,712.39
No. 61	82.26
No. 62	1,991.40
No. 63	110.74
No. 64	63.35
Railroad bridges:	
No. 1	29,491.77
No. 2	2,515.57
Aqueduct	50.00
Dam	1,282.75
Railroad	28,130.72
General construction	848.15
Superintendence and office	9,994.76
Care and repair of property and plant	127.53
Property	1,357.94
Material (stock on hand)	4,024.41
	408,738.91
Less material on hand June 30, 1900	7,455.59
Total for fiscal year 1901	401,283.32

Cost to close of fiscal year 1901.

	At close of 1900.	Fiscal year 1901.	Equitable part of general construction, superintendence and office, care and repair of property, and deterioration of property.	Total.
Surveys	$28,701.85			$28,701.85
Right of way	178,569.60	$93.76		a 132,907.66
Right of flowage	36,840.01	26,191.22		a 103,786.93
Feeder trunk:				
Mile 1	28,858.71	2,202.27	$76.83	31,132.81
Mile 2	25,911.47	168.58	5.88	26,085.93
Mile 3	2,920.59	9,468.01	329.59	12,718.19
Mile 4	16,261.56	1,817.48	63.28	18,142.32
Mile 5	12,459.26	183.43	6.37	12,649.06
Mile 6	24,920.45	170.00	5.92	25,096.37
Mile 7	27,781.42	150.00	5.22	27,936.64
Mile 8	21,509.39	154.50	5.39	21,669.28
Mile 9	3,144.52	7,873.12	274.06	11,291.70
Mile 10	7,384.03	250.66	8.73	7,643.42

a $40,755.70 erroneously charged "Right of way" transferred to "Right of flowage."

Cost to close of fiscal year 1901—Continued.

	At close of 1900.	Fiscal year 1901.	Equitable part of general construction, superintendence and office, care and repair of property and deterioration of property.	Total.
Feeder trunk—Continued.				
Mile 11	$1,422.10	$688.02	$23.95	$2,134.07
Mile 12	3,801.34	10,193.64	354.86	14,349.84
Mile 13	1,198.77	22,326.14	777.19	24,302.10
Mile 14	2,098.75	13,495.04	469.77	16,063.56
Mile 15	20,205.34	2,183.51	76.02	22,464.87
Mile 16	15,616.51	748.00	26.04	16,390.55
Mile 17	3,599.57	10,347.03	360.19	14,306.79
Mile 18	12,588.03	1,491.72	51.94	14,131.69
Mile 19	16,415.69	94.78	3.30	16,513.77
Mile 20	16,532.38	120.23	4.17	16,656.78
Mile 21	12,569.20	8,016.83	279.08	20,865.11
Mile 22	5,969.40	22,700.42	790.21	29,460.03
Mile 23	16,279.03	11,682.11	406.66	28,367.80
Mile 24	2,849.33	22,747.05	791.83	26,388.21
Mile 25	8,262.68	15,604.90	543.22	24,410.80
Mile 26	11,066.37	23,296.41	810.95	35,173.73
Mile 27	11,675.06	1,350.60	47.03	13,072.69
Mile 28	16,281.93	2,472.40	86.05	18,840.38
Mile 29	18,887.24	5,732.84	199.57	24,819.65
Culverts:				
No. 1	9,459.94	500.47	17.40	9,977.81
No. 2	7,611.20	480.60	16.74	8,108.54
No. 3	546.77	2,869.29	99.87	3,515.93
No. 4	7,045.33	3,168.50	110.31	10,324.14
No. 5	3,928.23	5,303.21	184.60	9,416.04
No. 6	2,403.66	8,683.14	302.26	11,389.06
No. 7	747.09	4,325.76	150.59	5,223.44
No. 8	1,721.06	9,854.14	343.02	11,918.22
No. 9	1,255.11	10,003.42	348.21	11,606.74
No. 10	254.93	3,108.13	108.19	3,471.25
No. 11 A	476.19	4,615.95	160.69	5,252.83
No. 11 B	640.75	213.32	7.41	861.48
No. 12	32.71	2,648.18	92.18	2,773.07
No. 13	235.64	2,685.81	93.50	3,014.95
No. 14	164.81	2,144.85	74.67	2,384.33
No. 15	2,276.83	414.00	14.41	2,705.24
No. 16	3,922.11	944.21	32.86	4,899.18
No. 17	2,596.88	13,578.09	472.66	16,647.63
Highway bridges:				
No. 43	19.99	....	....	19.99
No. 44	3,021.97	317.01	11.03	3,350.01
No. 45	2,239.06	2,738.39	95.31	5,072.76
No. 46	4,551.75	1,082.11	37.66	5,671.52
No. 47	5,669.45	1,560.12	54.30	7,283.87
No. 48	909.88	3,685.64	128.31	4,723.83
No. 49	182.17	5,422.74	188.78	5,793.69
No. 50	333.31	4,742.21	165.07	5,240.59
No. 51	126.84	748.55	26.07	901.46
No. 52	37.50	525.38	18.27	581.15
No. 53	630.72	30.63	1.08	662.43
No. 54	1,391.85	....	....	1,391.35
No. 55	37.50	1,201.28	41.81	1,280.59
No. 56	1,797.41	142.65	4.98	1,945.04
No. 57	595.56	....	....	595.56
No. 58	802.60	....	....	802.60
No. 59	2,427.49	3,202.69	111.50	5,741.68
No. 60	13.50	3,712.39	129.22	3,855.11
No. 61	975.64	82.26	2.85	1,060.75
No. 62	....	1,991.40	69.31	2,060.71
No. 63	587.32	110.74	3.86	701.92
No. 64	619.09	63.35	2.19	684.63
Railroad bridges:				
No. 1	4.16	29,491.77	1,026.64	30,522.57
No. 2	....	2,515.57	87.58	2,603.15
Aqueduct	....	50.00	1.74	51.74
Guard lock	80.03	....	....	80.03
Dam	....	1,282.75	44.66	1,327.41
Railroad	....	28,130.72	....	28,130.72
General construction	....	848.15	....	....
Superintendence and office	....	9,994.76	....	....
Care and repair of property	....	127.53	....	....
Property	3,409.97	1,357.94	....	3,978.26
Material (stock on hand)	7,455.59	4,024.41	....	4,024.41
		408,738.91		
Less material on hand June 30, 1900	....	7,455.59	....	....
Total	690,815.67	401,283.32	11,765.09	1,092,098.99

ILLINOIS AND MISSISSIPPI CANAL—EASTERN SECTION.

Annual statement, fiscal year 1901.

Surveys	$2,836.24
Right of way	328.50
Canal trunk:	
Mile 1	206.15
Mile 2	1,616.83
Mile 3	379.47
Mile 4	4,274.47
Mile 5	948.41
Mile 6	635.51
Mile 7	740.31
Mile 8	6,454.19
Mile 9	8,636.48
Mile 10	4,528.34
Mile 11	3,467.50
Mile 12	2,667.85
Mile 13	6,506.63
Mile 14	5,933.39
Mile 15	4,731.55
Mile 16	3,309.40
Mile 17	6,569.15
Mile 18	4,981.27
Mile 19	7,434.78
Mile 20	13,866.53
Mile 21	357.05
Mile 22	435.38
Mile 23	167.77
Mile 24	1,195.48
Mile 25	21,904.79
Mile 26	20,758.79
Mile 27	11,192.85
Mile 28	5,033.86
Locks:	
No. 6	285.58
No. 8	179.43
No. 9	354.35
No. 10	179.43
No. 11	179.43
No. 12	497.37
No. 13	464.71
No. 14	309.19
No. 15	179.42
No. 16	865.73
No. 17	179.42
No. 18	596.03
No. 19	235.92
No. 20	812.70
No. 21	1,246.68
Aqueducts:	
No. 1	958.22
No. 2	543.16
No. 3	340.57
Pipe culverts:	
No. 3	$1,353.16
No. 5	69.33
No. 7	913.65
No. 8	108.41
No. 15	659.25
Arch culverts:	
No. 1	1,496.26
No. 2	2,030.38
No. 4	2,052.87
No. 5	10.41
No. 7	2,483.40
No. 8	9,044.73
No. 9	7,994.78
Highway bridges:	
No. 1	1,372.51
No. 2	995.35
No. 5	5,784.19
No. 6	4,562.03
No. 7	5,563.55
No. 8	3,129.80
No. 9	3,245.88
No. 10	298.22
No. 11	689.55
No. 16	8,064.49
No. 17	9,039.25
No. 18	7,447.76
Railroad bridges:	
No. 1	2,738.16
No. 2	640.48
No. 3	38,692.25
House at Lock No. 19	251.08
Telephone line	143.93
General construction	5,380.78
Superintendence and office	14,423.91
Care and repair of property and plant	10,656.78
Maintenance of finished structures	1,960.85
Property	3,393.79
Material (stock on hand)	8,333.37
	325,530.85
Less material ($14,148.04) and lock forming ($5,610.63) on hand June 30, 1900	19,758.67
Total for fiscal year 1901	305,772.18

Cost to close of fiscal year 1901.

	At close of 1900.	Fiscal year 1901.	Equitable part of general construction, superintendence and office, care and repair of property, telephone line, and deterioration of property.	Total.
Surveys	$35,428.84	$2,836.24		$38,265.08
Right of way	130,508.42	328.50		130,836.92
Canal trunk:				
Mile 1	25,231.36	206.15	$26.01	25,463.52
Mile 2	25,798.16	1,616.83	204.20	27,619.19
Mile 3	21,846.68	379.47	47.98	22,274.13
Mile 4	45,920.36	4,274.47	539.72	50,734.55
Mile 5	33,775.20	948.41	119.71	34,843.32
Mile 6	17,920.13	635.51	80.31	18,635.95
Mile 7	25,670.81	740.31	93.45	26,504.57
Mile 8	23,348.73	6,454.19	815.01	30,617.93
Mile 9	33,724.62	8,636.48	1,090.68	43,451.78
Mile 10	31,423.68	4,528.34	571.80	36,523.82
Mile 11	39,233.95	3,467.50	437.94	43,139.39
Mile 12	29,807.80	2,667.85	336.92	32,812.57
Mile 13	31,669.29	6,506.63	821.70	38,997.62
Mile 14	25,469.32	5,933.39	749.22	32,151.93
Mile 15	31,516.63	4,731.55	597.56	36,845.74
Mile 16	32,859.74	3,309.40	417.86	36,587.00
Mile 17	30,024.34	6,569.15	829.52	37,423.01
Mile 18	16,322.42	4,981.27	629.00	21,932.69
Mile 19	37,407.63	7,434.78	938.89	45,781.30
Mile 20	22,929.20	13,866.53	1,751.13	38,546.86
Mile 21	712.41	357.05	45.08	1,114.54
Mile 22	788.50	435.38	54.93	1,278.81
Mile 23	775.18	167.77	21.22	964.17
Mile 24	11,334.00	1,195.48	151.03	12,680.51
Mile 25	3,983.10	21,904.79	2,766.16	28,654.05
Mile 26	2,677.84	20,758.79	2,621.45	26,058.08
Mile 27	1,687.68	11,192.85	1,413.45	14,293.98
Mile 28	7,763.35	5,033.86	635.69	13,432.90
Locks:				
No. 1	38,165.98			38,165.98
No. 2	40,814.12			40,814.12
No. 3	37,452.04			37,452.04
No. 4	36,721.74			36,721.74
No. 5	37,814.39			37,814.39
No. 6	39,886.13	285.58	36.12	40,207.83
No. 7	34,739.63			34,739.63
No. 8	33,642.46	179.43	22.72	33,844.61
No. 9	29,357.61	354.35	44.70	29,756.66
No. 10	31,431.65	179.43	22.72	31,633.80
No. 11	34,078.26	179.43	22.72	34,280.41
No. 12	32,674.23	497.37	62.76	33,234.36
No. 13	29,119.67	464.71	58.72	29,643.10
No. 14	28,569.74	309.19	39.02	28,917.95
No. 15	27,295.39	179.42	22.72	27,497.53
No. 16	30,599.50	865.73	109.36	31,574.59
No. 17	29,874.68	179.42	22.72	30,076.82
No. 18	32,262.14	596.03	75.26	32,933.43
No. 19	31,462.34	235.92	29.80	31,728.06
No. 20	34,002.06	812.70	102.67	34,917.43
No. 21	34,718.79	1,246.68	157.47	36,122.94
Pipe culverts:				
No. 1	3,295.57			3,295.57
No. 2	201.86			201.86
No. 3	7,273.18	1,353.16	170.86	8,797.20
No. 4	6,062.58			6,062.58
No. 5	3,358.56	69.33	8.71	3,436.60
No. 7	2,436.81	913.65	115.42	3,465.88
No. 8	2,675.42	108.41	13.64	2,797.47
No. 9	1,508.01			1,508.01
No. 10	1,915.65			1,915.65
No. 11	1,531.07			1,531.07
No. 15		659.25	83.22	742.47
At Peoria crossing	456.83			456.83
Arch culverts:				
No. 1	9,319.42	1,496.26	188.92	11,004.60
No. 2	6,929.92	2,030.38	256.35	9,216.65
No. 3	10,799.74			10,799.74
No. 4	13,393.70	2,052.87	259.25	15,705.82
No. 5	7,171.22	10.41		7,181.63
No. 6	8,154.17			8,154.17
No. 7	9,722.59	2,483.40	313.55	12,519.54
No. 8		9,044.73	1,142.20	10,186.93
No. 9		7,994.78	1,009.61	9,004.39

Cost to close of fiscal year 1901—Continued.

	At close of 1900.	Fiscal year 1901.	Equitable part of general construction, superintendence and office, care and repair of property, telephone line, and deterioration of property.	Total.
Aqueducts:				
No. 1	$40,748.47	$958.22	$120.98	$41,827.67
No. 2	52,959.52	543.16	68.57	53,571.25
No. 3	47,092.31	340.57	43.06	47,475.94
Highway bridges:				
Mile 5, No. 1	3,182.20	....	....	3,182.20
No. 1	4,453.77	1,372.51	173.38	5,999.66
No. 2	4,302.98	995.35	125.65	5,423.98
No. 3	4,179.16	....	....	4,179.16
No. 4	5,299.60	....	....	5,299.60
No. 5	10,874.15	5,784.19	730.40	17,388.74
No. 6	7,333.03	4,562.03	576.09	12,471.15
No. 7	7,214.47	5,563.55	702.62	13,480.64
No. 8	11,184.37	3,129.80	395.26	14,709.43
No. 9	7,350.94	3,245.88	409.91	11,006.73
No. 10	15,786.56	298.22	37.63	16,122.41
No. 11	416.59	689.55	87.13	1,193.27
No. 12	450.22	....	....	450.22
No. 13	296.22	....	....	296.22
No. 15	25.60	....	....	25.60
No. 16	720.58	8,064.49	1,018.45	9,803.52
No. 17	108.26	9,039.25	1,141.45	10,288.96
No. 18	98.78	7,447.76	940.53	8,487.07
Railroad bridges:				
No. 1	30,073.58	2,738.16	345.75	33,157.49
No. 2	58,905.19	640.48	80.95	59,626.62
No. 3	750.00	38,692.25	4,886.03	44,328.28
New highway, mile 16	5,542.91	....	....	5,542.91
Houses:				
At Lock No. 3	2,149.67	....	....	2,149.67
At Lock No. 6	1,247.43	....	....	1,247.43
At Lock No. 11	1,959.66	....	....	1,959.66
At Lock No. 13	430.10	....	....	430.10
At Lock No. 19	2,037.59	251.08	....	2,288.67
On mile 24	799.47	....	....	799.47
Lock forming	5,610.63	....	....	....
Telephone line	1,330.65	143.98	....	....
Railroad	20,000.00	....	....	20,000.00
General construction	....	5,880.78	....	....
Superintendence and office	....	14,423.91	....	....
Care and repair of property and plant	....	10,656.78	....	....
Maintenance of finished structures	....	1,960.85	....	1,960.85
Property	15,485.96	3,393.79	....	15,733.13
Material (stock on hand)	14,148.04	8,333.37	....	8,333.37
		325,530.85		
Less material ($14,148.04) and lock forming ($5,610.63) on hand June 30, 1900	....	19,758.67	....	....
Total	2,062,996.88	305,772.18	35,082.67	2,368,769.06

Expenditures Illinois and Mississippi Canal for fiscal year 1901.

Eastern section, Illinois River to Feeder junction	$305,772.18
Western section, Feeder junction to Rock River	264,651.85
Feeder line	401,283.32
Total	971,707.35

Total expenditures Illinois and Mississippi Canal to end of fiscal year 1901.

Eastern section	$2,368,769.06
Western section:	
Around rapids of Rock River	547,229.93
Rock River division	25,470.21
Feeder junction to Rock River	456,937.02
Feeder line	1,092,098.99
Total	4,490,505.21

List of contracts in force during fiscal year ending June 30, 1901, Illinois and Mississippi Canal.

Name and address of contractor.	Nature of contract.	Date.	To expire—	Extended to—	Completed.
Joel E. Loomis, Prophetstown, Ill	Earthwork miles 3 and 4, feeder.	Oct. 10, 1898	Sept. 3, 1899	Aug. 1, 1901	May 7, 1901
T. W. Kinser & Sons, Terre Haute, Ind.	Earthwork miles 12 to 16, feeder.	Dec. 15, 1898	July 31, 1900	July 31, 1901	....
Geo. W. Jackson Construction Co., Chicago, Ill.	Earthwork miles 17 and 18, feeder.	May 19, 1899	Dec. 31, 1899	Oct. 31, 1900	Oct. 31, 1900
Callahan Construction Co., Omaha, Nebr.	Earthwork miles 21 to 29, feeder.	.....do.......	July 31, 1901	Oct. 31, 1901	....
John J. McCaughey, Summit, Ill.	Earthwork miles 45 and 48, western section.	Nov. 22, 1899	Dec. 31, 1900	....	Nov. 9, 1900
Phelan & Wickham, Omaha, Nebr.	Earthwork miles 39, 41, 43, 44, 46, and 47, western section.	.....do.......	Sept. 1, 1901	....	....
T. W. Kinser & Sons, Terre Haute, Ind.	Earthwork mile 40, western section.	.....do.......	Dec. 31, 1900	July 1, 1901	June 1, 1901
Katz & Callahan, Omaha, Nebr.	Earthwork miles 28, 29, and 42, western section.	.....do.......	.....do.......	.....do.......	May 13, 1901
Do..............	Earthwork miles 26 to 28, eastern section.	Dec. 7, 1899	Dec. 1, 1900	Oct. 1, 1901	....
Benezette Williams, Chicago, Ill.	Earthwork miles 9 to 11, feeder.	Dec. 14, 1899	Dec. 31, 1900	Nov. 30, 1901	....
S. P. Bennett, Atkinson, Ill.	Earthwork mile 36, western section.	Sept. 1, 1900	Sept. 30, 1901	....	....
Katz & Callahan, Omaha, Nebr.	Earthwork miles 37 and 38, western section.	.....do.......	.....do.......	....	....
Pound Construction Co., Chicago, Ill.	Earthwork mile 34, western section.	.....do.......	.....do.......	....	....
Flynn Bros., Sheffield, Ill.	Earthwork miles 33 and 35, western section.	.....do.......	.....do.......	....	....
T. W. Kinser & Sons, Terre Haute, Ind.	Earthwork miles 50–52, western section.	May 10, 1901	Dec. 31, 1901	....	....
Katz & Callahan, Omaha, Nebr.	Earthwork mile 49, and new channels in Green River.	.....do.......	.....do.......	....	....
Toledo Bridge Co., Toledo, Ohio.	Superstructure 5 highway bridges.	Dec. 12, 1899	July 31, 1900	Nov. 15, 1900	Nov. 15, 1900
Chicago Bridge and Iron Works, Chicago, Ill.	Superstructure 1 double track railroad bridge.	Apr. 18, 1900	Oct. 20, 1900	....	Oct. 20, 1900
Lassig Bridge and Iron Works, Chicago, Ill.	Superstructure 1 single track railroad bridge.	Aug. 15, 1900	Feb. 17, 1901	....	Jan. 26, 1901
La Fayette Bridge Co., Lafayette, Ind.	Superstructure 1 double track highway bridge.	Nov. 26, 1900	Apr. 1, 1901	June 30, 1901	....

REPORT OF MR. J. C. LONG, ASSISTANT ENGINEER.

PRINCETON, ILL., *July 1, 1901.*

MAJOR: I have the honor to submit the following report of operations on the work under my supervision, comprising the eastern section of the Illinois and Mississippi Canal, extending from mile 1 on the right bank of the Illinois River, 2 miles above Hennepin, Ill., to mile 27.8, at the Feeder Junction, 4 miles northwest of Sheffield, Ill., for the fiscal year ending June 30, 1901.

CONDITION OF THE WORK AT THE BEGINNING OF FISCAL YEAR.

The line of the canal had been definitely located from mile 1 to mile 27.8, the right of way condemned and paid for, and inclosed with a barbed-wire fence.

Earthwork on canal trunk for the first 18 miles was complete, except one-third of a mile on mile 1, next to Illinois River, reenforcement of high embankments, lining canal trunk with water-tight material where required, approaches to highway bridges 5 to 9, inclusive. On mile 19 the earthwork was 89 per cent complete, and on mile 20 it was 42 per cent complete. No earthwork had been done on miles 21 to 23 inclusive. On mile 24 the earthwork was 40 per cent complete; on mile 25, 21.4

per cent complete; on mile 26, 15 per cent complete; on mile 27, 20 per cent complete, and on mile 28 about 76 per cent complete. All concrete masonry except spillway at Lock 21, flushing arrangements at culverts, abutments for railroad bridge Chicago, Burlington and Quincy Railroad crossing, abutments for highway bridges 11 to 18 inclusive, culverts under approaches to highway bridges 16 and 17, and arch culverts 8 and 9 had been completed.

All cast-iron pipe culverts except No. 15 on mile 25 had been completed.

Bank revetment on the first 16 miles had been practically completed. On mile 17 about 50 per cent had been completed.

Storage yards had been established at Bureau, Lock 17, and Wyanet, and connected with Chicago, Rock Island and Pacific Railway for the purpose of receiving and caring for material and supplies.

A narrow-gauge railroad track had been built along the canal embankment, from the storage yard at Bureau to Lock 19, on mile 17, near Wyanet, with side tracks connecting with yards, gravel pits, and lock sites.

Buildings had been erected as follows: Houses to shelter locomotives at Bureau, Locks 6 and 19; two warehouses at Bureau, one at Lock 17, and one at Lock 19; three superintendents' houses, one each on mile 2, mile 11, and Mile 17; two lock-keepers' houses, one on mile 7 and the other on mile 13, and a small house of four rooms for office use on mile 24.

The following shows the contracts in force during the fiscal year:

Abstracts of contracts for constructing the eastern section of the Illinois and Mississippi Canal in force during the fiscal year ending June 30, 1901.

Name and address of contractor.	Nature of contract.	Date of contract.	To expire—
Katz & Callahan, Omaha, Nebr.	Earthwork miles 26, 27, and 28	Dec. 7, 1899	Dec. 1, 1900. Extended to Oct. 1, 1901.
Toledo Bridge Co., Toledo, Ohio.	Steel superstructure and erection of highway bridges 5, 6, 7, 8, and 9.	Dec. 12, 1899	July 31, 1900. Extended to Sept. 30, 1900.
Chicago Bridge and Iron Co., Chicago, Ill.	Steel superstructure and erection of railroad bridge No. 3.	Apr. 18, 1900	Within five months and ten days of approval of contract.

WORK PERFORMED DURING THE YEAR.

MILE 1.

Setting slope stakes, cutting weeds, repairing fence, and inspecting		$246.78
Total work, Mile 1		246.78

MILE 2.

Earthwork:		
5,591 cubic yards handled in building embankments above high water, connecting embankments at railway bridge No. 1, and excavating and back filling at highway bridge No. 1, at 18.7 cents per cubic yard		1,050.05
Stonework:		
Bank revetment—		
158.81 tons rubblestone	$204.08	
Labor placing same	394.54	
		598.62
(529.1 square yards, at $1.131 per square yard.)		
Splay wall, Railway Bridge No. 1—		
480.8 tons rubblestone	617.74	
75.5 barrels Portland cement	162.32	
Labor placing same	1,422.43	
		2,202.49
(112.11 cubic yards laid in cement, at $8.89 cubic yard; 307.50 cubic yards laid dry, at $3.92.)		
Splay wall, Highway Bridge No. 1—		
Tearing out 40 feet bulging dry-laid wall and rebuilding with cement-laid masonry, viz—		
695 tons rubblestone	877.45	
33 barrels Portland cement	61.38	
Labor placing same	805.21	
		1,744.04
(81.21 cubic yards, at $11.78 per cubic yard; 625 tons rubblestone previously used and charged to this structure.)		

Stonework—Continued.		
Railroad Bridge, Peoria crossing—		
For parapet walls—		
3¼ barrels Portland cement	$6.99	
Building walls, painting, etc	107.10	
Inspecting steel superstructure at shops	61.25	
Equitable distribution of forming for abutments	203.35	
		$378.69
Maintenance—		
Cutting weeds	121.62	
Repairing right-of-way fence	13.51	
Cleaning out seep ditch	22.64	
		157.77
Total work, Mile 2		6,131.66

MILE 3.

Earthwork:		
3,710 cubic yards, removing railway cross over, filling over-bank revetment, connecting embankments near Arch Culvert No. 1, and excavating and connecting embankments at Arch Culvert No. 2, at 15.7 cents per cubic yard		585.80
Arch Culvert No. 1 (partly constructed last season):		
Building splay walls and flushing arrangement and cleaning out culvert—		
121.1 tons rubblestone	$155.61	
114.75 barrels Portland cement	246.71	
5 tons coal	10.50	
2 kegs nails	5.50	
Labor	507.36	
		925.68
(27 cubic yards splay walls, $2.77 per cubic yard; 150 cubic yards splay wall, $1.24 per cubic yard; 107 cubic yards concrete masonry, $7.15 per cubic yard.)		
Arch Culvert No. 2:		
Building flushing arrangement, paving and cleaning out culvert, viz:		
70 tons rubblestone	89.95	
117 barrels Portland cement	216.45	
10 tons coal	21.00	
2 kegs nails	5.50	
40 feet drain pipe	4.80	
20 gallons coal oil	2.55	
Labor	1,575.21	
		1,915.46
Maintenance:		
Cutting weeds	126.60	
Repairing right-of-way fence	10.50	
Reseeding embankments	2.43	
		139.53
Total work, Mile 3		3,566.47

MILE 4.

Earthwork:		
17,564 cubic yards, enlarging channel of East Bureau Creek, building protection embankments, reenforcing and filling over-bank revetment, at 20 cents per cubic yard		3,512.70
Stonework:		
Revetting end of protection embankment, 52 tons rubblestone	$66.82	
Labor	153.95	
		220.77
(169 square yards, at $1.30 per square yard.)		
Aqueduct No. 1:		
Loading steel superstructure on cars at Lock 17, delivering same at aqueduct site, and placing same in position		588.74

Right of way:		
Purchase of right of way for enlarging channel of East Bureau Creek.		$159.00
Maintenance:		
Cutting weeds	$113.98	
Repairing fence	6.00	
Sodding embankments, Lock 4	36.95	
Painting superstructure, Aqueduct 1	81.63	
Reseeding embankments	7.50	
Painting quoin castings, Lock 4	2.61	
		248.67
Total work, Mile 4		4,729.88

MILE 5.

Earthwork:		
3,646 cubic yards, reenforcing embankments and filling over-bank revetment, at 18.3 cents per cubic yard		666.26
Stonework:		
Revetting approach to highway bridge, new channel Bureau Creek—		
46.8 tons rubblestone	$60.14	
Labor, placing same	67.73	
Labor, repairing wash	55.14	
		183.01
Maintenance:		
Cutting weeds	62.08	
Sodding approaches to Lock 5	43.50	
Placing stone to prevent encroachment of Bureau Creek on canal embankments	46.04	
Building bridge across seep ditch near highway bridge No. 2	12.00	
Repairing fence	3.55	
Reseeding embankments	4.50	
		171.67
Total work, Mile 5		1,020.94

MILE 6.

Earthwork:		
1,738 cubic yards, reenforcing high embankments, excavating and refilling overflushing arrangement at Pipe Culvert No. 3, at 18 cents per cubic yard		312.76
Stonework:		
100 tons rubblestone	$128.50	
Labor, building obstruction dam across seep ditch to prevent encroachment of Bureau Creek on canal embankments	68.94	
		197.44
Pipe Culvert No. 3:		
Flushing arrangement—		
5 sections 48-inch cast-iron pipe 12 feet long	365.00	
90½ tons rubblestone	166.52	
18½ barrels Portland cement	39.77	
Labor	697.37	
		1,268.66
Maintenance:		
Cutting weeds	43.25	
Planting willows	25.00	
Repairing fence	16.52	
		84.77
Total work, Mile 6		1,863.63

MILE 7.

Earthwork:		
2,966 cubic yards reenforcing high embankments, building protection embankment at Chicago, Rock Island and Pacific Railroad crossing, at 16 cents per cubic yard		$475.54
Arch culvert No. 4:		
Cleaning culvert and building foundation for flushing arrangement, 331 cubic yards excavation	$213.71	
49 tons coal	108.78	
Operating pump	356.37	
Cleaning out culvert	233.35	
Driving sheet piling	13.13	
		925.34
Concrete masonry:		
Flushing arrangement, at arch culvert 4:		
103¼ barrels Portland cement	221.99	
12 tons of coal	26.64	
38 gallons oil	5.80	
1 keg nails	2.75	
Erecting and wrecking forming	129.66	
Cutting 5 by 9 foot hole at top of arch	44.71	
Hauling gravel	62.70	
Operating pump	99.00	
Mixing and placing concrete	212.12	
		805.37
Paving intake, arch culvert No. 4:		
66.88 tons rubblestone	85.94	
Labor placing same	120.02	
		205.96
(109 square yards at $1.89 per square yard.)		
Railway Bridge No. 2:		
9 piles	18.63	
Equitable distribution of forming	288.05	
Building parapet wall	61.70	
Inspecting steel superstructure at shop	106.74	
Painting steel superstructure	123.92	
		599.04
Warehouse, Lock No. 6:		
Tearing down, removing across canal, and rebuilding:		
17,000 shingles	46.75	
3 kegs of nails	8.85	
Labor	171.16	
		226.76
Maintenance:		
32 tons rubblestone repairing bank revetment and railroad track	41.12	
Labor placing same	30.96	
Cutting weeds	120.25	
Reseeding embankments	1.88	
Sodding approach to Highway Bridge 3	11.96	
		206.17
Total work, Mile 7		3,444.18

MILE 8.

Earthwork:		
28 tons of coal, used in locomotive	$60.60	
17,250 cubic yards reenforcing embankments, at 22.7 cents per cubic yard	3,844.94	
Total work, Mile 8		3,905.54

MILE 9.

Earthwork:		
47 tons of coal used in locomotive	$100.20	
20,663 cubic yards reenforcing high embankments and soiling same	5,433.24	
		5,533.44

Stonework:		
Bank revetment—		
Labor laying 147 square yards, at 42.3 cents per square yard		$62.16
Splay wall, Lock 9—		
47.7 tons rubblestone	$62.64	
Labor	112.28	
		174.92
(28.3 cubic yards, at $6.18 per cubic yard.)		
Pipe culvert No. 5:		
Labor in placing 67.44 square yards, at 97 cents per square yard		65.41
Maintenance:		
Cutting weeds	57.00	
Sodding approaches to Lock 8	36.75	
Sodding approaches to Lock 9	31.51	
Repairing fence	24.06	
Reseeding embankments	4.57	
		153.89
Total work, Mile 9		5,989.82

MILE 10.

Earthwork:		
37 tons coal used in locomotive	$77.70	
Royalty on additional earth	25.00	
10,160 cubic yards reenforcing high embankments	2,527.30	
1,244 cubic yards completing approaches to Highway Bridge No. 5	383.96	
1,222 cublic yards excavating and refilling to prevent leak	245.03	
		3,258.99
Stonework:		
Bank revetment—		
97½ tons rubblestone	125.59	
Labor placing same and rebuilding 645 square yards	268.22	
		393.81
Highway Bridge No. 5:		
Fencing approaches—		
207 fence posts	37.26	
3,112 feet B. M. lumber	68.46	
1 keg nails	2.75	
Labor erecting fence	71.32	
Steel superstructure (contract)	2,476.67	
Inspection at shops	24.51	
240 cubic yards gravel for approaches	12.00	
15 barrels Portland cement	42.85	
Labor placing gravel on roadway	343.34	
Inspecting and testing steel superstructure	41.64	
Painting steel superstructure	47.66	
Equitable distribution of forming	175.00	
		3,343.46
Maintenance:		
Cutting weeds		50.10
Total work, Mile 10		7,046.36

MILE 11.

Earthwork:		
16 tons coal used in locomotive	$34.50	
Royalty on additional earth	25.00	
17,663 cubic yards reenforcing high embankments and lining canal prism with water-tight material, at 15.8 cents per cubic yard	2,788.24	
		2,847.74
Stonework:		
Bank revetment—		
20.6 tons rubblestone	26.50	
Labor	24.33	
		50.83
(61 square yards, at 83.3 cents per square yard.)		

Highway Bridge No. 6:		
Steel superstructure (contract)	$3,400.00	
Inspecting steel superstructure at shops	24.51	
Equitable distribution of forming	109.90	
Removing temporary bridge	26.40	
Inspecting and testing	77.22	
		$3,638.03
Maintenance:		
20 tons rubblestone	30.84	
Rebuilding 277 square yards bank revetment	164.60	
Cutting weeds, burning rubbish, etc	134.47	
Repairing fence	68.45	
Putting in drive well	9.71	
Reseeding embankments	4.31	
		412.38
Total work, Mile 11		6,948.98

MILE 12.

Earthwork:		
11,038 cubic yards reenforcing high embankments, at 24.2 cents per cubic yard		2,675.76
Stonework:		
Bank revetment—		
50 tons rubblestone	$64.25	
Labor placing same	196.16	
		260.41
(279 square yards, at 69 cents per square yard.)		
Aqueduct No. 2:		
Equitable distribution of forming	463.55	
5 barrels Portland cement	11.10	
		474.65
Lock No. 12:		
Clay lining for preservation of lock bottom and to prevent leakage		237.25
Maintenance:		
Operating pump at Lock 12	144.34	
Cutting weeds	103.53	
Repairs to fence	46.70	
		294.57
Total work, Mile 12		3,942.64

MILE 13.

Earthwork:		
18,258 cubic yards reenforcing high embankments, at 21.2 cents per cubic yard		3,861.39
Stonework:		
Splay walls, Highway Bridge No. 7—		
Labor in placing same		225.07
(250 square yards, at 90 cents per square yard.)		
Bank revetment—		
380 tons rubblestone	$480.05	
Labor in placing same	1,522.80	
		2,002.85
(2,136 square yards, at 94 cents per square yard.)		
Retaining wall, Highway Bridge No. 7—		
Labor, excavating	11.67	
Labor, delivering materials	33.19	
Labor, stone-mason work	142.92	
53 tons rubblestone	68.10	
1 barrel Portland cement	2.15	
		258.03
(42½ cubic yards rubble masonry, at $5.79 per cubic yard.)		

Stonework—Continued.		
Cast-iron pipe culvert No. 7—		
Flushing arrangement—		
Handling cast-iron pipe	$63.75	
165 cubic yards excavating, refilling and removing mud	32.79	
Stone-mason work	247.91	
Laying up splay wall	100.43	
109 tons rubble stone	139.02	
37¾ barrels Portland cement	81.16	
		$665.06
(62 cubic yards rubble masonry, at $5.40 per cubic yard; 115 square yards splay wall, at $1.43 per square yard.)		
Highway Bridge No. 7:		
1,735 cubic yards earthwork in south approach	405.44	
550 cubic yards gravel	245.21	
Inspecting and testing span	116.32	
Erecting 1,600 linear feet fence on approaches	90.68	
Painting 1,600 linear feet fence on approaches	37.01	
Steel superstructure (contract)	2,500.00	
Inspection of steel superstructure at shops	24.51	
1 barrel of Portland cement	2.15	
Equitable distribution of forming	160.65	
		3,581.97
Lock No. 13:		
Clay lining for preservation of lock bottom and to prevent leakage		269.15
Maintenance:		
Cutting weeds	110.36	
Repairs to 2,468 linear feet fence	99.76	
Building brush dam to prevent encroachment of Bureau Creek on canal embankments	195.26	
Repairs to lock house at Lock 13	3.33	
Operating steam pump at Lock 13	168.15	
		576.86
Total work, Mile 13		11,440.38

MILE 14.

Earthwork:		
11,239 cubic yards reenforcing high embankments, at 23.6 per cubic yard	$2,679.91	
7,200 cubic yards clay lining, at 28.4 cents per cubic yard	2,044.86	
		4,724.77
Stonework:		
Bank revetment—		
Labor in placing same		198.46
(379 square yards, at 52.3 cents per square yard.)		
Lock No. 14:		
Clay lining for preservation of lock bottom and to prevent leakage		88.68
Highway Bridge No. 8:		
Inspecting and testing span	117.89	
Steel superstructure (contract)	2,462.01	
Equitable distribution of forming	123.90	
		2,703.80
Flushing arrangement, double arch culvert No. 7:		
Concrete masonry—		
Erecting and removing forms	114.26	
Hauling materials	128.37	
Concrete work, labor	253.83	
145 barrels Portland cement	313.37	
60 tons crushed stone	99.00	
85 cubic yards gravel	44.38	
Nails	13.75	
Equitable distribution of forming	46.25	
		1,013.21
(138 cubic yards concrete masonry, at $7.34 per cubic yard.)		

Flushing arrangement, double arch culvert No. 7—Continued.		
Setting guide castings—		
1,035 cubic yards excavation, backfilling, and removing mud	$468.64	
Drilling openings in arches	110.62	
Setting 4 guide castings	29.50	
4 guide castings and bolts	97.35	
		$706.11
Splay walls—		
160 tons of rubblestone	205.60	
Laying stone in walls	410.40	
6¼ barrels Portland cement	13.44	
Coal used in locomotive	24.21	
		653.65
(330 square yards splay wall, at $1.98 per square yard.)		
Maintenance:		
Cutting weeds	79.06	
Rebuilding 5,280 linear feet fence	101.03	
Seeding and soiling embankments	172.44	
		352.53
Total work, Mile 14		10,441.21

MILE 15.

Earthwork:		
13,070 cubic yards in soiling slopes, ditching towpath in excavation, in approaches to aqueduct No. 3, and drainage ditch along north side of right of way to prevent surface water entering canal		3,059.61
Stonework:		
Bank revetment—		
Labor laying 144 square yards and repairing washouts		187.00
Lock No. 16:		
700 cubic yards earth excavation and backfilling	$318.18	
Placing 2 lengths 42-inch cast-iron pipe	85.95	
Laying 38 cubic yards rubble masonry	106.57	
15 barrels natural cement	11.10	
3 barrels Portland cement	6.45	
2 lengths 42-inch cast-iron pipe	103.94	
		632.19
Pipe culvert No. 8:		
Splay walls—		
Labor	76.00	
1 barrel Portland cement	2.15	
20 tons rubblestone	25.70	
		103.85
(45 square yards, at $2.31 per square yard.)		
Highway bridge No. 9:		
1,125 cubic yards earth in approaches	223.08	
Steel superstructure (contract)	2,441.67	
Inspection of steel superstructure at shops	24.51	
Inspecting and testing span	84.44	
Erecting 800 linear feet fence on approaches	78.61	
1 barrel Portland cement	2.15	
Equitable distribution of forming	121.80	
		2,976.26
Maintenance:		
Cutting weeds	136.35	
Soiling and seeding embankments	126.74	
Repairing right of way fence	160.85	
		423.94
Total work, Mile 15		7,382.85

MILE 16.

Earthwork:		
5,545 cubic yards in soiling slopes, in approaches to Lock 18 and clay lining in canal prism, at 27 cents per cubic yard		$1,580.67
Stonework:		
Bank revetment—		
Labor placing stone (stone charged in previous year)	$1,063.77	
10 tons coal, at $2.35 per ton	23.50	
		1,087.27
Splay walls, Lock 18—		
70 tons rubblestone	89.95	
6 barrels Portland cement	15.30	
Labor placing stone	120.67	
		225.92
(140 square yards, at $1.62 per square yard.)		
Splay wall, highway bridge No. 10—		
35 tons rubblestone	44.98	
14 barrels natural cement	6.30	
Labor placing stone	230.06	
		281.34
(40 cubic yards, at $7.03 per cubic yard.)		
Maintenance:		
Cutting weeds	93.50	
Placing tile for surface drainage into canal	9.00	
		102.50
Total work, Mile 16		3,277.70

MILE 17.

Earthwork:		
10,360 cubic yards, reenforcing high embankments, soiling slopes, placed on north side of canal between Lock 19 and Chicago, Burlington and Quincy Railroad bridge and in approaches to said birdge, at 27.1 cents per cubic yard		2,808.48
Stonework:		
Bank revetment—		
750 tons rubblestone	$963.75	
16.5 tons coal, used in locomotive	37.12	
Labor, placing stone	1,104.06	
		2,104.93
Splay walls, Chicago, Burlington and Quincy Railroad bridge—		
440 tons rubblestone	565.41	
5 barrels Portland cement	9.10	
116 barrels natural cement, at 74 cents	85.84	
98 barrels natural cement, at 80 cents	78.40	
Labor, placing same	1,515.63	
		2,254.38
(250.5 cubic yards mortar wall, and 81 cubic yards dry wall laid, at $6.50 per cubic yard.)		
Parapet wall, Chicago, Burlington and Quincy Railroad bridge:		
15 tons rubblestone	19.28	
2 barrels Portland cement	4.30	
Labor, placing same	86.10	
		109.68
(12 cubic yards, at $9.14 per cubic yard.)		
Chicago, Burlington and Quincy Railroad Bridge:		
Foundation—		
12,600 cubic yards earthwork, at 24 cents per cubic yard	3,028.20	
250 piles	500.00	
350 barrels natural cement	157.50	
170 cubic yards gravel	56.67	
Bolts, spikes, and nails	2.30	
Equitable distribution of forming	60.00	
Freight on pile driver from Bureau, Ill	10.77	
Labor driving piles, mixing and depositing concrete	902.06	
		4,717.50

Chicago, Burlington and Quincy Railroad Bridge—Continued.		
Concrete masonry—		
1,450½ barrels Portland cement	$3,118.58	
1,150 barrels natural cement	517.50	
1,635 cubic yards of gravel	545.00	
880.85 tons crushed stone	1,399.74	
45 tons coal used in locomotive	101.27	
Spikes and nails	25.80	
Coal oil	109.65	
Equitable distribution	682.00	
Freight on natural cement	15.04	
Labor on forms, mixing and depositing concrete	6,163.71	
		$12,678.29
(1,350 cubic yards Portland cement concrete, at $7.187 per cubic yard; 600 cubic yards natural cement concrete, at $4.96 per cubic yard.)		
Steel and iron superstructure (contract)—		
12,950 pounds cast iron	515.41	
423,821 pounds wrought steel	16,868.08	
		17,383.49
Miscellaneous charges—		
Bolts	22.54	
Chicago office charges	209.23	
Laboratory charges for testing steel	54.59	
Inspection	821.10	
		1,107.46
(Total cost of the Chicago, Burlington and Quincy Railroad Bridge, including cost of parapet wall, $109.68, is $35,996.42, of which labor to the amount of $1,479.16 was performed in the previous year.)		
Superintendents' house, Lock 19:		
Constructing cistern, putting in pumps, sink, waste pipes, etc		236.87
Maintenance:		
Cutting weeds	$98.75	
Placing tile for surface drainage into canal	93.56	
Repairing right-of-way fence	15.62	
		207.93
Total work Mile 17		43,609.01

MILE 18.

Earthwork:		
5,600 cubic yards in approaches to and fills behind walls of Locks 20 and 21, at 18 cents	$1,010.33	
Repairs to embankment and to Sheffield road at its crossing with canal where damaged by spring freshets	250.46	
Ditching in bottom of canal to secure flow of water to cover floors of Locks 20 and 21	145.37	
		1,406.16
Stonework:		
Bank revetment—		
760 tons rubblestone	976.60	
16.5 tons coal used in locomotive	37.12	
Labor in placing same	1,182.51	
		2,196.23
Splay walls, Lock 20—		
75 tons rubblestone	96.38	
60½ barrels natural cement	42.23	
5.2 tons coal used in locomotive	11.70	
Labor, laying stone, pumping, etc	419.40	
		569.71
(180 square yards, at $3.16 per square yard.)		
Splay walls, Lock 21—		
160 tons rubblestone	205.60	
Labor placing same	515.57	
		721.17
(384 square yards, at $1.88 per square yard.)		

Concrete masonry:		
Spillway, Lock 21—		
32 barrels Portland cement	$68.80	
64 tons crushed stone	101.04	
1 keg nails	2.81	
Equitable distribution of forming	11.70	
Labor placing masonry	73.61	
		$257.96
Highway Bridge No. 11—		
Additional land for approaches	600.00	
Fees for recording transfers	1.50	
Services of inspectors and laborers in surveying for additional land, side staking farm road and plat of site	163.37	
		764.87
Peterson Creek Intake:		
400 linear feet of 24-inch sewer pipe, used to conduct the water of Peterson Creek from its point of entrance into the canal right of way into the canal prism just below Lock 20	316.00	
Labor, delivering pipe, digging trench for same, laying pipe, backfilling and constructing protection wall at its inlet	640.92	
		956.92
Maintenance:		
Cutting weeds	57.00	
Repairing right-of-way fence	11.25	
		68.25
Total work, Mile 18		6,941.27

MILE 19.

Double 48-inch pipe culvert under highway at Station No. 975:		
120 linear feet 48-inch cast-iron pipe	$913.75	
44 barrels natural cement	32.56	
10 barrels Portland cement	21.50	
4,000 feet B. M. timber for grillage	100.00	
Delivering pipe	64.34	
Delivering gravel for concrete and roadbed	239.00	
Excavation for foundations	137.18	
Constructing foundations and headwalls	112.58	
Placing pipe	27.66	
Back filling	194.24	
		1,842.81
Maintenance:		
Opening drainage ditches along right of way	46.83	
Repairing right-of-way fence	22.25	
		69.08
No other work has been done on this mile other than as stated above, and no other expenditure has been made except settlement of claim of Globe Construction Company for work performed during last year, amounting to		5,234.68
Total work, Mile 19		7,146.57

MILE 20.

Double 48-inch pipe culvert under highway at Station No. 1005:		
144 linear feet 48-inch cast-iron pipe	$1,106.08	
47 barrels natural cement	34.78	
10 barrels Portland cement	21.50	
4,000 feet B. M. timber for grillage	100.00	
Delivering pipe	72.96	
Delivering gravel for concrete and road bed	288.50	
Excavating for foundations	210.20	
Constructing foundations and headwalls	122.70	
Placing pipe	42.00	
Backfilling	220.51	
		2,219.23

Maintenance:	
Repairs to right-of-way fence	$15.51
No other work has been done on this mile than as stated above, and no other expenditure has been made except settlement of claim of Globe Construction Company for work performed during last year, amounting to	10,906.79
Total work, Mile 20	13,141.53

MILE 21.

Right-of-way fence:	
1,650 linear feet of right-of-way fence has been constructed, at a cost of	51.45
Total work, Mile 21	51.45

MILE 22.

Right-of-way fence:	
3,614 linear feet of right-of-way fence has been constructed, at a cost of	169.78
Total work, Mile 22	169.78

MILE 23.

No work has been done on this mile, and no expenditure made, except settlement of claim of Globe Construction Company for work performed during last year, amounting to	37.32

MILE 24.

Earthwork:		
620 cubic yards excavation	$124.00	
Building dike across canal prism, ditching and pumping	446.56	
3 barrels gasoline, used in pumping engine	22.50	
8 tons of coal	19.20	
30 feet 18-inch sewer pipe	9.60	
Tearing down warehouse at Bureau, moving same, and erecting locomotive shed	118.76	
Tearing up and hauling track material from Miles 1, 2, and 3	580.98	
Laying track, building traps, trestles, coal bins, and water tank	369.07	
15,300 feet B. M. old forming lumber used in trestles, etc.	153.00	
Cutting weeds	53.65	
Total work, Mile 24		1,897.32

Earth work about 26 per cent complete.

MILE 25.

Earth work:
92,797 cubic yards excavation.
17,466 cubic yards embankments.
10,159 cubic yards excavation in drainage ditches.
3,600 cubic yards excavation in seed ditches.

124,022 cubic yards total, at 15.8 cents per cubic yard	$19,599.10	
Material used in repairing drainage ditches—		
14 barrels natural cement	8.96	
¾ barrel Portland cement	1.33	
18 tons rubblestone	26.73	
150 feet 12-inch sewer pipe	21.75	
9,170 square yards sodding on slopes of drainage ditch	887.07	
2,500 feet tiling in drainage ditch to prevent interference with quicksand	821.78	
		21,366.72

Pipe Culvert No. 15 (partly completed):		
Excavation for foundation	$600.00	
Mixing and placing 45 cubic yards concrete	78.25	
Building head wall	38.97	
Hauling material	425.61	
132 tons rubblestone	196.02	
84 barrels natural cement	37.80	
5,000 feet old forming timber in foundation	50.00	
8 pieces of 30-inch cast-iron pipe	482.02	
50 pounds oakum	.50	
1 keg nails	2.75	
800 pounds pig lead	36.00	
9½ tons of coal	22.80	
		$1,970.72
Erection of tool house		121.92
Total work, Mile 25		23,459.36

Earth work on this mile 85 per cent complete.

MILE 26.

Earth work:		
71,590 cubic yards, at 11.6 cents per cubic yard (contract)	$8,304.44	
11,315 cubic yards, in approaches to Highway Bridge No. 16, at 11.6 cents per cubic yard (contract)	1,312.53	
2,090 cubic yards, constructing temporary roadway at Bridge No. 16, at 16 cents per cubic yard	334.32	
		9,951.29
Stonework:		
Bank revetment—		
2,189 tons rubblestone	4,027.76	
Labor, placing same	4,146.95	
		8,174.71
(4,402 square yards, at $1.86 per square yard.)		
Paving at Arch Culvert No. 8—		
30 tons rubblestone	44.98	
6 tons of coal	14.50	
Labor, placing same	454.51	
		513.99
(220 square yards, at $2.34 per square yard.)		
Foundation at Arch Culvert No. 8—		
13,451 cubic yards excavation, at 20 cents per cubic yard	2,959.31	
140 piles	280.00	
Bolts, spikes, and nails	35.78	
205 barrels natural cement	92.25	
41½ tons coal	101.50	
Labor	1,348.76	
		4,817.60
Concrete masonry in Arch Culvert No. 8—		
517¼ barrels Portland cement	920.70	
175¾ barrels Portland cement	377.85	
75 gallons of coal oil	9.55	
12 tons of coal	29.00	
Equitable distribution of forming	298.30	
Labor	2,077.74	
		3,713.14
(415 cubic yards concrete masonry, at $8.94 per cubic yard.)		
Highway Bridge No. 16:		
Concrete masonry—		
223½ barrels Portland cement	481.50	
137 tons crushed stone	204.66	
70 gallons coal oil	8.92	
Equitable distribution of forming	124.60	
Labor	865.98	
		1,685.66
(178 cubic yards concrete masonry, at $9.47 per cubic yard; partly constructed during past season.)		

Highway Bridge No. 16—Continued.		
Retaining wall—		
108 tons rubblestone	$160.38	
26 barrels natural cement	29.13	
Labor, placing same	289.50	
		$479.01
(61 cubic yards, at $7.85 per cubic yard.)		
Arch culvert under north approach to Highway Bridge No. 16:		
2,120 cubic yards excavation	381.70	
45½ barrels natural cement	18.25	
15½ tons coal	37.86	
Labor	250.57	
		688.38
Concrete masonry—		
307½ barrels Portland cement	549.31	
8½ tons coal	20.00	
Labor	885.01	
		1,454.32
(156 cubic yards concrete masonry, at $9.31 per cubic yard.)		
Total work, Mile 26		31,478.10

Earth work on this mile is 98 per cent complete.

MILE 27.

Earth work:		
18,287 cubic yards, at 11.6 cents per cubic yard (contract)	$2,121.29	
62,849 cubic yards loosely deposited earth work, at 10.6 cents per cubic yard (contract)	6,661.99	
12,000 cubic yards in approaches to Highway Bridge No. 17, at 11.6 cents per cubic yard (contract)	1,392.00	
Building temporary roadway at Bridge 17	360.21	
		10,535.49
Paving at Arch Culvert No. 9:		
30 tons rubblestone	44.98	
6.5 tons coal	15.85	
Labor, placing same	478.16	
		538.99
(220 square yards, at $2.45 per square yard.)		
Foundation at Arch Culvert No. 9:		
7,735 cubic yards excavation	1,392.37	
136 piles	272.00	
Bolts, spikes, and nails	35.78	
222¼ barrels natural cement	110.00	
45.7 tons coal	110.95	
Labor	1,602.66	
		3,523.76
Concrete masonry, arch culvert No. 9:		
549¾ barrels Portland cement	961.13	
77 gallons coal oil	9.55	
12.5 tons coal	31.70	
Equitable distribution of forming	309.85	
690 cubic yards gravel	93.90	
47 tons crushed stone	70.50	
Labor	2,455.40	
		3,932.03
(448 cubic yards concrete masonry, at $8.78 per cubic yard.)		
Highway Bridge No. 17:		
2,414 cubic yards excavation	482.88	
378¼ barrels natural cement	170.20	
545 cubic yards gravel	68.20	
Equitable distribution of forming	56.00	
Labor	1,056.14	
		1,833.42

Highway Bridge No. 17—Continued.		
Concrete masonry—		
222¼ barrels Portland cement	$474.75	
137 tons crushed stone	204.66	
70 gallons coal oil	8.92	
406 cubic yards gravel	40.90	
Equitable distribution of forming	100.10	
Labor	1,257.00	
		$2,086.33
(178 cubic yards concrete masonry, at $11.72 per cubic yard.)		
Arch culvert under approach to Bridge 17:		
Foundation—		
717 cubic yards excavation	387.24	
40¼ barrels natural cement	59.48	
14.3 tons coal	34.65	
Labor	320.13	
		801.50
Concrete masonry—		
346½ barrels Portland cement	617.10	
13.2 tons coal	32.41	
58½ gallons oil	7.43	
Labor	795.03	
		1,451.97
(157 cubic yards concrete masonry, at $9.25 per cubic yard.)		
Retaining wall, Highway Bridge No. 17:		
126 tons rubblestone	231.84	
74½ barrels natural cement	33.45	
72 cubic yards gravel	9.00	
Labor	446.39	
		720.68
(70 cubic yards retaining wall, at $10.29 per cubic yard.)		
Cast-iron pipe drain under south approach to Highway Bridge No. 17:		
7 pieces cast-iron pipe	227.64	
20 barrels natural cement	9.00	
19½ tons rubblestone	28.25	
74½ cubic yards gravel	9.33	
Labor	226.68	
		500.90
Total work, Mile 27		25,925.07

(Earthwork on this mile is 95 per cent complete.)

MILE 28.

Earthwork:		
Earthwork by contract on this mile is 85 per cent complete and the contractors have been paid during the year for, viz—		
8,844 cubic yards in canal trunk, at 11.6 cents per cubic yard.	$1,025.91	
18,622 cubic yards loosely deposited earthwork in canal trunk, at 10.6 cents per cubic yard	1,973.93	
17,500 cubic yards in bridge approaches, at 11.6 cents	2,030.00	
	5,029.84	
Less 10 per cent retained	502.98	
		4,526.86
Stonework:		
Bank revetment—		
2,246 tons rubblestone	4,132.92	
Labor placing same	4,652.14	
		8,785.06
(5,004 square yards bank revetment, at $1.75 per square yard.)		

Highway Bridge No. 18:		
880 cubic yards excavation	$219.04	
370 barrels natural cement	210.90	
133 cubic yards gravel	17.10	
Equitable distribution of forming	72.00	
Labor	1,470.41	
		$1,989.45
Concrete masonry—		
198 barrels Portland cement	504.90	
128 tons crushed stone	201.52	
172 gallons coal oil	21.93	
407 cubic yards gravel	51.75	
Equitable distribution of forming	100.55	
Labor	1,728.78	
		2,609.43
(178 cubic yards concrete masonry, at $14.66 per cubic yard.)		
Retaining wall:		
106 tons rubblestone	157.41	
63 barrels natural cement	33.75	
Labor	621.60	
		812.76
(80 cubic yards retaining wall, at $10.60 per cubic yard.)		
Tile drain under south approach to Highway Bridge No. 18		69.52
Total work, Mile 28		18,793.08

SURVEYS.

The remainder of the plats and descriptions required for securing right of way along line "F" were completed. Options were secured from each of the landowners, and a tabular statement was prepared giving the names of owners, number of acres of land required, estimated value, estimated damages, and amount of option. A topographical map of the region in the vicinity of the proposed change of line, and an index map to accompany the right of way papers were prepared, and these, together with an abstract of title, three copies of the plat and description of each tract and two copies of the owners' proposal were forwarded to the Chicago office.

The entire length of line "F" (5.3 miles) was side staked and nearly all of the cross sections platted and areas calculated.

The work of the Globe Construction Company on Miles 19, 20, and 23 was recross-sectioned to show the condition of the work, test pits dug to verify classification of material excavated and the quantities of material rechecked.

A board consisting of myself and Inspectors Browne, Truss, Woermann, and Wright was appointed to review the subject of the line through Cecil's Slough and the alternative lines. Numerous test pits and borings were made and a careful estimate compiled of the cost of each line, together with a report on the relative values, in the estimation of the board, of each line.

INSPECTION AND TESTS OF CEMENT.

All cement used on the work was subjected to a rigid inspection and was tested for tensile strength by a Fairbanks tensile testing machine, and was expected to meet the following requirements:

FOR HYDRAULIC PORTLAND CEMENT.

First. The minimum tensile strength in pounds per square inch of briquettes exposed twenty-four hours in moist air after mixing, and six or twenty-seven days in water, to be as follows:

	7 days old.	28 days old.
Neat cement	450	540
1 cement to 3 standard sand, by weight	135	210

Second. The cement to be ground to such fineness that 99 per cent by weight shall pass through a No. 50 sieve, and 87 per cent through a No. 100 sieve in use in this office.

Third. The cement to be slow setting, not beginning to set as determined by the vicat needle, one-twelfth inch diameter, under one-fourth pound pressure, in forty minutes, and not to bear a weight of 1 pound on a wire one twenty-fourth inch diameter in three hours, but to bear such weight in ten hours.

Fourth. The cement to be free from all substances that may produce a deleterious expansive action in paste or mortar made therefrom. The cement not to warp, crack, check, or show other indications of unsoundness when made into thin cakes and exposed to air and water at ordinary temperature, nor when exposed to steam or boiling water for a period of about four hours, provided that cement shall be allowed to set hard and remain fourteen hours in moist air before being subjected to the above hot test.

FOR NATURAL HYDRAULIC CEMENT.

First. The minimum tensile strength in pounds per square inch of briquettes exposed twenty-four hours in moist air after mixing, and six or twenty-seven days in water, to be as follows:

	24 hours.	7 days.	28 days.
Neat cement	50	90	180
1 cement to 1 standard sand, by weight	....	75	180

Second. The cement to be ground to such fineness that at least 90 per cent shall pass through a No. 50 sieve, and 78 per cent through a No. 100 sieve in use in this office.

Third. The cement to be slow setting, not to begin to set as ascertained by the vicat needle in less than thirty minutes, but must set hard in ten hours.

Fourth. The cement must not warp, check, or crack when made into thin cakes and exposed to air and water at ordinary temperatures.

The following brands of cement were used on this work during the fiscal year, viz:

Portland cement.—"Atlas," "Dragon," and "Marquette."

Natural cement.—"Utica," Clark brand.

* * * * * * *

MISCELLANEOUS WORK.

Experimental lock gate.—An experimental gate and maneuvering chamber and valve, on the plan of Marshall's automatic gate, was constructed at Lock No. 18, bulkheads erected at the upper end of Lock No. 19 and lower end of Lock 18, and a head of water accumulated during the erection of the gate. After the completion of the gate, there not being sufficient water to fill the level between Locks 18 and 19 to a depth of 7 feet, an earth dam was constructed across the canal prism about 200 feet above Lock 18 and the required depth obtained by pumping. The gate was successfully operated several times on three occasions.

After the completion of the tests the water was allowed to flow into the level below Lock 18 and thence into West Bureau Creek, the earth dam and bulkhead at Lock 18 removed, and all the wood and iron work of the gate and maneuvering chamber painted.

Cost.

Gate and maneuvering chamber:		
2,700 feet B. M. oak timber	$169.92	
5,000 feet B. M. pine timber	125.00	
Bolts and castings	69.70	
Chicago office charges	29.95	
Labor	774.32	
		$1,168.89
Bulkheads, dam, and operating expense:		
11,000 feet B. M. pine timber	275.00	
10 tons coal	22.50	
Labor	1,045,54	
		1,343.04
Total cost		2,511.93

Sixteen miles of narrow-gauge railway track and 17 miles of telephone line, connecting assistant engineer's office at Princeton with ten stations along the line of canal, has been maintained and kept in operation. Near the end of the year 1½ miles of the narrow-gauge track east of Lock 4 was torn up and transported to Mile 24, to be relaid for use in transporting water-tight earth to build embankments through Devils Slough on Mile 24.

Three locomotives in use on the work after close of working season were loaded on cars and shipped to the builders at Pittsburg and Philadelphia for repairs.

EMPLOYEES.

I have been assisted on this work by the following gentlemen, to whom I am indebted for faithful performance of duty: As senior inspectors, Charles A. Browne, J. D. Truss, S. L. Bayless, Henry Fox, and Joseph Wright; junior inspectors, C. A. Clement, H. J. Emmons, M. B. Long, G. W. Choate, and S. E. Bayless; clerk in charge of office and accounts, C. F. Scott, assisted by G. C. Falconer; receiver of material, E. V. Williams; inspector of cement, Willis Hunter, and timekeeper, H. L. Mills.

I have the honor to be, your obedient servant,

Jas. C. Long, *Assistant Engineer.*

Maj. J. H. Willard,
Corps of Engineers, U. S. A.

REPORT OF MR. L. L. WHEELER, ASSISTANT ENGINEER.

Sterling, Ill., *July 10, 1901.*

Major: I have the honor to submit the following report on the work done on the Illinois and Mississippi Canal under my supervision during the fiscal year ending June 30, 1901:

FEEDER.

During the year proceedings for securing right of way for the feeder and for the western section of the main line were in progress. The papers in the case of the United States *v.* Hugh D. Duffy et al., involving lands in Lee County to be flowed, were forwarded to Washington and the proceedings approved by the Attorney-General and payment of awards made.

The papers in the case of the United States *v.* Jeremiah H. Rickel et al., involving lands in Henry County, were forwarded to Washington and the title approved by the Attorney-General, except for three parcels of land. Payment has been made for these lands except the three parcels, the title to which was not approved by the Attorney-General. It was found on account of the necessity for obtaining material for highway approaches and also ground on which to build the approaches that additional lands would be necessary along the feeder. Proceedings for acquiring these lands were commenced and the damages awarded by a jury on May 7, 1901. The decree in the case has not yet been filed.

At the beginning of the year all the earthwork was under contract, and 3,259,602 cubic yards had been excavated. During the year 1,145,964 cubic yards were excavated. The following table shows the distribution of this earthwork:

	Cubic yards.		Cubic yards.
Mile 3	59,100	Mile 22	88,010
Mile 9	73,240	Mile 23	25,910
Mile 10	9,942	Mile 24	154,085
Mile 11	45,500	Mile 25	77,802
Mile 12	93,470	Mile 26	102,675
Mile 13	212,250	Mile 28	100
Mile 14	92,300	Mile 29	25,200
Mile 17	70,150		
Mile 21	16,230	Total	1,145,964

Work was in progress under the contract of the Callahan Construction Company for the construction of pipe culverts and foundations of arch culverts, and it is expected that this contract will be completed during the present month of July. The work remaining is the completion of slope paving of Culvert No. 6, and any needed repairs to the work. The following table shows the amount of work executed under this contract:

Piles driven and cut off	485	Bolts, spikes, etc., placed, pounds	4,221
Pine timber placed . feet B. M.	35,414	Rubble masonry laid, cubic yards	156.04
Oak timber placed . . . . do	184	Earthwork excavated, cubic yards	24,824
Sheeting placed . . . . do	42,900	36-inch cast-iron pipe laid and calked . . . . linear feet	293.54
Pine plank placed . . . . do	33,270	48-inch cast-iron pipe laid and calked . . . . linear feet	628
Portland-cement concrete deposited . . . . cubic yards	122.6		
Natural-cement concrete deposited . . . . cubic yards	726.8		
Slope paving placed, square yards	1,035.3		

The concrete masonry for three 10-foot arch culverts and for flushing devices for two 36-inch pipe culverts was built by hired labor. The back filling over culvert 4 and culvert 5 was also done by hired labor. Culvert No. 17, a double 12-foot arch culvert, was entirely completed by the purchase of material and construction by hired labor. After the foundation was finished and all but about 50 feet of the arch completed complaint was made by farmers living east of the culvert that the foundation was not low enough to properly drain their lands. This matter was thoroughly investigated at the time, and while it was believed that the culvert was of ample proportions and low enough to meet any drainage that the farmers were likely to undertake, it was thought best to provide for a possible lower drainage by constructing a box sluice under one of the arches. This was done by removing the concrete between the grillage timbers and constructing underneath them a box culvert having a clear opening of 2 by 5 feet 6 inches. The bottom of this box culvert is 3 feet 1 inch below the floor of the culvert proper. At the time this was done a steam dredge was excavating a deep ditch west of the culvert, but as the landowners permitted this dredge to stop a thousand feet west of the culvert, it is quite probable that this box culvert will never be brought into use for drainage purposes.

At the beginning of the year work was in progress on the masonry for seven highway bridges. The foundations and abutments were completed and the vertical retaining wall and slope paving for five of them also completed. Work upon the bridges was delayed by the issuing of five writs of injunction by the circuit court of Whiteside County, Ill., at the instance of highway commissioners. These writs covered practically all the bridges in the first 16 miles of the feeder and entailed considerable expense upon the United States and some loss to the contractors for execution of earthwork. Four of the writs were dismissed in the United States circuit court, and one still remains in force. Work on the bridges stopped with the completion of the masonry on account of these proceedings, and it is not contemplated to resume work on the approaches until the matter is finally concluded in the courts. The superstructure for bridge 44 at Rock Falls was under contract before these proceedings commenced. The superstructure of this bridge and the approaches have been completed and the bridge is now in use by the public.

The bridge for the Chicago, Burlington and Quincy Railroad Company over the feeder, near Rock Falls, was built and the traffic is now passing over it. The exact total cost of the bridge can not yet be stated, as some bills of the railway company for use of locomotives and cars have not yet been presented. The slope paving can not be completed until the temporary turn-out is removed. Under this turn-out is a large amount of good concrete material, and it is not expected to entirely remove the turn-out until use can be made of this concrete material.

During the year plans and estimate of cost were prepared for a movable dam across Rock River at the head of the feeder. The plans have been referred to a Board of Engineers for examination and report. Report and estimate of cost was also prepared for a lock to be placed in this dam in order to give access to pool along the city fronts of Sterling and Rock Falls. Preparations were made for revetting the banks of the feeder with the stone to be excavated from mile 1. About one-half mile of east bank was revetted with teams. Ten miles of railway-track material, 6 flat cars, 50 dump cars, and other appliances were purchased, and about 3 miles of track laid.

WESTERN SECTION.

The earthwork for a portion of mile 29 and miles 30 to 32, inclusive, had not been placed under contract for the reason that the drainage in this vicinity was undetermined. During the past year a large tract of land in this vicinity has been organized into a drainage district, and two steam dredges are at present dredging the ditches. Under the drainage project Kink Creek, Lawtons Creek, and Coal Creek have been brought together into one channel before crossing the right of way for the canal, and the water level in the swamp in mile 31 has been lowered about 4 feet below the surface of the ground. It was considered advisable to obtain more right of way through this low ground, and also to obtain more for three highway crossings in that vicinity. Proceedings for acquiring this right of way were instituted in connection with the proceedings for more right of way on the feeder, and the verdict in the case returned on May 7, 1901.

Miles 49 to 52, inclusive, were fenced, under contract with Hamann & Liedke. The contract for south fence was $205.75 per mile, and for north fence $235.50 per mile. The contract was also let to the same parties for building the remainder of the fence on mile 31, and rebuilding about one-half mile of fence where larger pieces of land were required for canal purposes. About 5 miles of right of way were staked out, slope stakes set, and quantities of earthwork computed. Specifications were prepared for 13 miles of earthwork, the work for 10 miles advertised, and miles 33 to 36, inclusive, placed under contract September 1, 1900, and miles 49 to 52 placed under contract May 10, 1901. The following table gives the names of the successful bidders and the contract prices for the earthwork:

Mile.	Lowest bidder.	Earthwork.	Price per yard.
		Cubic yards.	*Cents.*
33	Flynn Bros	108,858	9.9
34	Pound Construction Co.	113,216	10
35	Flynn Bros	112,570	6.5
36	Solomon P. Bennett	91,085	7.5
37	Katz & Callahan	113,796	11.5
38	.....do	174,728	14.75
49	.....do	154,507	15.98
50	T. W. Kinser & Sons	98,542	11
51	.....do	92,495	8.5
52	.....do	110,492	8.5

At the beginning of the year, 414,773 cubic yards of earthwork had been executed. During the year, 1,297,739 cubic yards were executed. The following table shows the distribution of this earthwork:

	Cubic yards.		Cubic yards
Mile 28	21,017	Mile 41	81,360
Mile 29	16,550	Mile 42	109,100
Mile 33	74,905	Mile 43	78,180
Mile 34	47,100	Mile 44	18,220
Mile 35	67,270	Mile 45	60,700
Mile 36	17,025	Mile 46	118,470
Mile 37	114,640	Mile 47	70,042
Mile 38	178,000	Mile 48	48,900
Mile 39	65,910		
Mile 40	110,350	Total	1,297,739

At the beginning of the year, the construction of the foundations for four arch culverts and the construction of 14 pipe culverts was in progress, the single bid received for their construction having been rejected. The foundations for three of the arch culverts have been completed and the excavation of the pit for the fourth one is now in progress. Thirteen of the pipe culverts have been entirely completed and the construction of the fourteenth one is now in progress and nearing completion. The following table shows the total cost of 12 of the pipe culverts and the various items making up these totals, and the unit costs for the various items of work. While culvert 23 has been completed, yet the data are not available for this culvert for inserting in the table. Culvert No. 20 is the one now under construction. This table includes the cost of engineering, superintendence, and a charge for deterioration of plant.

Table of quantities, unit cost, and total cost, western section pipe culverts.

No.	Size.	Earthwork.			Natural cement concrete.			Portland cement concrete.			Rubble masonry.		
		Quantity.	Unit cost.	Total cost.	Quantity.	Unit cost.	Total cost.	Quantity.	Unit cost.	Total cost.	Quantity.	Unit cost.	Total cost.
	In.	*Cu. yds.*			*Cu. yds.*			*Cu. yds.*			*Cu. yds.*		
18	36	1,497	$0.17	$255.12	....	....	....	51.5	$10.96	$564.21	10.6	$13.66	$144.81
19	48	1,558	.21	322.74	....	....	....	66.4	11.07	735.16	12.7	10.37	131.74
22	48	2,504.6	.26	652.54	74.58	$8.76	$653.05	4.27	12.32	52.59	38.42	9.11	350.19
25	48	2,796.4	.21	585.32	59.17	8.15	482.40	57.34	8.43	483.17	26.4	8.40	221.78
26	2-48	2,744.5	.24	651.22	125.57	6.00	753.89	7.87	9.65	75.94	67.5	7.57	511.10
27	2-48	3,035.2	.22	655.97	143.5	5.19	744.71	16.4	5.71	93.72	66.33	8.09	536.76
28	36	1,029.8	.22	221.49	66.11	6.49	429.21	5.01	7.60	38.08	24.68	9.65	238.24
29	48	1,705.3	.21	352.10	57.4	7.39	424.43	53.8	8.96	481.94	41.1	8.83	363.00
31	2-48	1,665.5	.23	390.95	129.07	6.22	803.26	14.17	7.85	111.21	30.66	8.27	253.67
32	48	1,773.3	.26	457.34	64.2	6.67	427.99	8.93	7.02	62.73	58.6	7.72	452.26
33	48	1,979.5	.32	627.01	75.91	6.78	515.00	7.83	8.33	65.24	65.97	7.26	478.65
34	48	1,770	.18	327.02	86	7.15	614.58	2.5	8.62	21.54	29.4	8.82	259.55
Total..		24,059.1	.23	5,498.82	881.51	6.63	5,848.52	296.02	9.41	2,785.53	472.36	8.34	3,941.75

Tables of quantities, unit cost, and total cost, western section pipe culverts.—Continued.

No.	Size.	Slope paving.			Pipe laying.			Deterioration of plant.	Engineering and superintendence.	Cost of culverts complete.
		Quantity.	Unit cost.	Total cost.	Quantity.*a*	Unit cost.	Total cost.			
	In.	*Sq. yds.*			*Ft. In.*					
18	36	68.7	$2.87	$197.16	145 0	$6.03	$874.88	$16.00	$241.18	$2,293.36
19	48	71.3	2.88	205.19	145 5	9.01	1,309.98	30.00	49.61	2,784.42
22	48	70.69	3.67	259.37	157 7	9.33	1,470.03	32.50	75.17	3,545.44
25	48	63.62	3.72	236.52	132 4	9.72	1,286.14	42.50	49.59	3,387.42
26	2-48	103.52	3.99	413.42	266 8	8.94	2,382.99	45.00	86.23	4,919.79
27	2-48	81.56	3.49	284.25	267 2	8.96	2,394.61	54.60	75.97	4,840.59
28	36	52.94	4.11	217.40	144 9	6.21	898.23	16.00	135.24	2,193.89
29	48	79.9	3.19	254.85	133 7	8.92	1,192.05	52.10	95.97	3,216.44
31	2-48	59.38	3.66	217.33	291 4	8.90	2,594.33	43.00	66.26	4,480.01
32	48	93	3.44	319.61	134 1	8.96	1,201.99	40.10	69.96	3,031.98
33	48	101.27	3.77	381.37	133 5	9.09	1,212.19	32.01	49.59	3,361.06
34	48	48	3.22	154.52	170 0	8.90	1,513.63	40.10	97.61	3,028.55
Total.		893.88	3.51	3,140.99	(*b*)	(*b*)	18,331.05	443.91	1,092.38	41,082.95

a Linear feet.
b Thirty-six inch pipe: 289 feet 9 inches; unit cost, $6.12; total cost, $1,773.11. Forty-eight inch pipe: 1,831 feet 7 inches; unit cost, $9.04; total cost, $16,557.94.

As it may be of interest to compare the cost of the twelve culverts as constructed by the United States and what would have been their cost under the single bid received, the following table is inserted. In this table no charge has been made for superintendence and inspection, as the cost would have been the same by either method of construction. There are some items in the total cost of the culverts which would not have been included under the contracts. This table is intended to exhibit the cost of such portions of the work as are comparable. The total cost of the twelve culverts is $39,049.92, while their cost under the bid received would have been $49,567.53, leaving a profit to the United States of $10,517.61, or a profit of about 26.9 per cent.

Comparison of cost of western section pipe culverts.

Culvert.	At contractor's prices.	Actual cost.	Difference.
No. 18	$2,449.95	$2,046.14	$403.81
No. 19	3,303.12	2,703.96	599.16
No. 20			
No. 22	3,990.41	3,454.94	535.47
No. 23			
No. 25	3,702.45	2,906.02	796.43
No. 26	6,244.44	4,812.57	1,431.87
No. 27	6,369.49	4,688.10	1,681.39
No. 28	2,420.64	2,039.05	381.59
No. 29	3,582.38	2,711.52	870.86
No. 31	5,660.15	4,390.50	1,269.65
No. 32	3,840.54	2,982.63	857.91
No. 33	4,250.61	3,403.51	847.10
No. 34	3,753.35	2,910.98	842.37
Total	49,567.53	39,049.92	10,517.61

In Mile 49 a pipe line belonging to the Chicago, Rock Island and Pacific Railway Company is crossed, and as it is above bottom grade it was necessary to make some provision for changing this pipe line. Plans for doing this work were prepared and submitted to the railway company for approval. The necessary pipe have been delivered on the ground, but not yet laid. Plans were prepared for two 12-foot arch culverts, but their construction has not yet been entered upon.

The crossings of the railways near Colona have been under investigation. An estimate was prepared of the cost of changing the grade so as to permit fixed bridges, and a report upon the matter submitted.

A series of tests of Portland cement for culverts were made. Out of 800 barrels for culvert No. 17, 500 were rejected. While none of the cement complied with the specifications, yet 300 barrels standing the highest tests were used in the side walls. This brand of cement was exceedingly slow setting, and lacked soundness and uniformity. Some of the briquettes at the end of twenty-four hours could not be taken from the molds without breaking. The cement for culverts 21 and 30, on the other hand, is extremely quick setting, the initial set of 700 barrels taking place in from five to ten minutes, and the final set in from twenty to thirty minutes. It is probable that the whole 700 barrels will be rejected.

Very respectfully, your obedient servant,

L. L. Wheeler,
Assistant Engineer

Maj. J. H. Willard,
Corps of Engineers, U. S. A.

M M 8.

SURVEY OF UPPER ILLINOIS AND LOWER DES PLAINES RIVERS, ILLINOIS, WITH A VIEW TO THE EXTENSION OF NAVIGATION FROM THE ILLINOIS RIVER TO LAKE MICHIGAN AT OR NEAR CHICAGO, ILLINOIS.

At close of last fiscal year all field work had been completed and the regular survey from Lockport to La Salle plotted, the foot contours worked out, and the greater part inked in. The special survey between Sag and Calumet had been reduced. The work of inking in the foot contours on maps of regular survey and plotting and completing drawings of special survey were completed and a final report submitted by the Board of Engineer officers on November 17, 1900.

This report was published as House Document 112, Fifty-sixth Congress, second session, and is also herewith.

Money statement.

July 1, 1900, balance unexpended	$12,509.04
June 30, 1901, amount expended during fiscal year	6,163.85
July 1, 1901, balance unexpended	6,345.19

FINAL REPORT ON SURVEY OF UPPER ILLINOIS AND LOWER DES PLAINES RIVERS, ILLINOIS, WITH A VIEW TO THE EXTENSION OF NAVIGATION FROM ILLINOIS RIVER TO LAKE MICHIGAN AT OR NEAR CHICAGO.

[Printed in House Doc. No. 112, Fifty-sixth Congress, second session.]

Office of the Chief of Engineers,
United States Army,
Washington, December 4, 1900.

Sir: The river and harbor act approved March 3, 1899, contains the following item:

> Illinois River and Des Plaines River, Illinois: The Secretary of War is directed to appoint a board of three engineers, which board shall make a survey and estimates of cost for the improvement of the Upper Illinois River and Lower Des Plaines River, in Illinois, with a view to the extension of navigation from the Illinois River to Lake Michigan at or near Chicago; said board of engineers shall report the estimates of cost

for a channel seven feet deep, and also for a channel eight feet deep, throughout said proposed route; said survey and estimates of cost shall be made in pursuance of and according to the recommendations in report of January twenty-seventh, eighteen hundred and ninety-seven, and there is hereby appropriated for the expenses of said board and such survey the sum of thirty thousand dollars, or so much thereof as may be necessary.

Preliminary report dated March 17, 1900, by the Board of Engineers appointed by authority of the Secretary of War in accordance with requirements of the above-quoted item of law, was submitted to the Secretary of War with my letter of March 24, 1900, and is printed in House Doc. No. 548, Fifty-sixth Congress, first session, and in my Annual Report for 1900, page 3856 et seq.

I have now the honor to submit the accompanying copy of the Board's final report on the subject dated November 17, 1900.

The plans presented are for waterways of 7 and 8 feet depth from Utica to Marseilles in the bed of the river, thence around the Marseilles Rapids by canal, thence in the bed of the river to near the mouth of the Kankakee, thence through the Illinois and Michigan Canal to the Joliet Basin, thence by canal to the Sanitary Canal at Lockport, and thence via the Sanitary Canal and Chicago River to Lake Michigan. These projects involve the construction of 12 locks and 2 dams with movable weirs, the estimated cost being:

For the 7-foot project	$7,317,977
For the 8-foot project	8,653,247

These estimates are based upon the assumption that such franchises as are necessary in connection with the constructions contemplated will be ceded free of cost to the United States.

The cost of an independent 8-foot waterway from Sag Bridge on the Sanitary Canal to Lake Michigan via the Little Calumet and Calumet rivers (the Sag route) is estimated at $5,680,186, making a total of $14,333,433 as the estimated cost of an 8-foot waterway via the Sag route.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

Hon. ELIHU ROOT,
Secretary of War.

REPORT OF BOARD OF ENGINEERS.

CHICAGO, ILL., *November 17, 1900.*

GENERAL: The Board of Engineer Officers constituted by paragraph 1, Special Orders, No. 14, March 12, 1899, headquarters Corps of Engineers, United States Army, in accordance with the provisions of the act of March 3, 1899, to make "a survey and estimates of cost for the improvement of the Upper Illinois River and Lower Des Plaines River, in Illinois with a view to the extension of navigation from the Illinois River to Lake Michigan at or near Chicago," submitted a preliminary report March 17, 1900, with estimates for channels 8 feet and 7 feet deep. (House Doc. No. 548, Fifty-sixth Congress, first session.)

The Board reconvened at Chicago November 9, 1900, and having revised its estimates after fuller information now presents its final report.

The Board finds the most economic route for waterways of 7 feet and 8 feet depth to be from Utica to Marseilles in the bed of the river, 11.4 miles; thence around the Marseilles rapids by canal, 7.4 miles; thence in the bed of the river to near the mouth of Kankakee River, 21.2 miles; thence by enlarging the Illinois and Michigan Canal to the Joliet Basin, 18.3 miles; thence by canal through Joliet Basin and along the east bank of the Des Plaines River, 4¼ miles, connecting with the Sanitary Canal at Lockport, and thence through the Sanitary Canal and the Chicago River to Lake Michigan, thus complying with the terms of the act of March 3, 1899.

For the 8-foot project the dimensions proposed for the river sections and canal from Utica to the mouth of the Des Plaines River are not less than 300 feet wide at bottom for the river divisions and not less than 170 feet surface width for canal, with depths in the river divisions of 8 feet below extreme low water and in the canal of 10 feet. Existing railroad and highway bridges over these divisions must be remodeled to give suitable draw openings over the proposed channels. With locks of the same dimensions as the United States and State locks now in operation in the lower Illinois River, viz, 75 feet wide by 350 feet between miter sills, steamboat navigation will be extended to the head of the Illinois River.

For the remaining canal divisions the width will be not less than 130 feet at water surface and the depth 10 feet, but the locks are reduced to 40 feet width by 260 feet between miter sills. With fixed bridges giving 22 feet headroom, the Board is of the opinion that these dimensions should furnish ample navigation for the largest barges heretofore in use on the Mississippi River, and that the combination will afford a waterway of 10 feet depth at stages 2 feet above extreme low water in the Illinois River of sufficient capacity for any through barge traffic likely to seek it.

To overcome a mean difference of elevation of 133 feet between the river surface at Utica and the surface of the Sanitary Canal at Lockport, with allowances for variations in stages at either end of the route, twelve locks have been provided as follows:

Locks 75 by 350 feet.—Utica River Division: One lift lock, 15 feet lift. Marseilles Canal: Two lift locks, each 15 feet lift; 1 guard lock.

Locks 40 by 260 feet.—Canal to Joliet Basin: Three lift locks, each 15 feet lift; 1 lift and guard lock, 15 to 9 feet. Canal, Joliet Basin to Lockport: Two lift locks, each 12 feet lift; 1 lift lock, 10 feet; 1 lift and guard lock, 10 feet to 0.

Two dams will be required, one at Utica and one at the head of the Marseilles Canal.

The Board is of the opinion that both dams should be surmounted by some form of movable weir to reduce the elevation of flood discharge by an amount at least equal to that which has been caused by the additional discharge from the Sanitary Canal.

The 7-foot waterway will follow the same route as that for 8 feet through barge navigation to Lake Michigan at Chicago. The principal reduction in the estimates is in the amount of excavation, the dimensions permitting little change in the cost of locks and other structures.

Estimates.

	7-foot project.	8-foot project.
UTICA DIVISION.		
Dam and movable weir	$106,000	$106,000
1 lock	307,807	317,575
River walls	57,098	57,098
Levees	69,667	69,667
Excavation, rock	73,250	210,125
Marseilles Canal:		
3 locks	616,343	645,247
River walls	105,282	105,282
Levees	16,410	16,410
Excavation	446,455	494,396
Revetment	45,500	45,500
Kankakee Pool:		
Dam and movable weir	146,000	146,000
Excavation	65,375	156,025
Enlarging Illinois and Michigan Canal:		
4 locks	561,212	584,578
Excavation, rock	77,598	778,876
Excavation, earth	402,094	353,426
Culverts	75,000	75,000
Aqueduct	100,000	105,000
Canal Joliet to Sanitary Canal:		
4 locks	487,798	512,490
Excavation, rock	234,675	327,594
River walls	464,750	464,750
Culverts	75,000	75,000
Bridges	865,000	865,000
Right of way and damages	700,000	700,000
Engineering and contingencies, 20 per cent	1,219,663	1,442,208
Total	7,317,977	8,653,247

As in the preliminary report, the Board invites attention to the fact that the estimates are based upon the assumption that the State of Illinois and the sanitary trustees of the city of Chicago will cede the necessary parts of their respective franchises free of cost to the United States both for construction and use.

THE SAG ROUTE.

Since the Board's report of March 17, 1900, the trustees of the sanitary district have undertaken to cooperate with the United States in deepening the South Branch of Chicago River to 21 feet and widening it to at least 200 feet. They have already planned to substitute seven bascule bridges for the center-pier bridges now obstructing the river. It is expected that this project will be extended, and that the city of Chicago will undertake a part of the bridge reconstruction and lower, or cause to be lowered, the three tunnels now limiting the navigable depth of the river to 17 feet. The fears entertained with respect to the dangers of navigating the South Branch of the river under the new conditions of reversed flow have been allayed to a great degree by the practical experience of the past season. For this reason, and because the plans for both the 7-foot and 8-foot waterways comply with the requirements of the act contained in the words "with a view to the extension of navigation from the Illinois River to Lake Michigan at or near Chicago" in connecting with the Sanitary Canal, the Board is of the opinion that the additional cost will not justify the construction at the present time of an auxiliary canal from the Sanitary Canal to Lake Michigan by way of the Sag and Calumet route, and is also of the opinion that such a route would not become a necessity until the commerce of either the 7-foot or 8-foot route should develop to a degree not expected for years.

The estimates for this auxiliary route are based upon the same dimensions for canal and structures as those for the canal from the Illinois River to Lockport in the 8-foot project.

Estimate for the Sag route.

1 lock connecting with Sanitary Canal at Sag Bridge	$155,000
Rock excavation	603,800
Earth excavation	1,924,688
Bridges	1,500,000
Right of way	550,000
Engineering contingencies, 20 per cent	946,698
Total	5,680,186
Grand total for 8-foot waterway by the Sag route	14,333,433

The report of Assistant Engineer James A. Seddon is appended, and there accompanies the report an index map with profile and nineteen maps[1] of the route from the Sanitary Canal at Lockport to La Salle on the Illinois River.

Money statement.

Amount appropriated by act approved March 3, 1899	$30,000.00
Amount expended to November 17, 1900	22,155.88
Outstanding liabilities	3,044.12
Balance available	4,800.00
	30,000.00

Respectfully submitted.

J. W. Barlow,
Colonel, Corps of Engineers.
J. H. Willard,
Major, Corps of Engineers.
C. McD. Townsend,
Major, Corps of Engineers.

Brig. Gen. John M. Wilson,
Chief of Engineers, U. S. A.

REPORT OF MR. JAMES A. SEDDON, ASSISTANT ENGINEER.

United States Engineer Office,
Chicago, Ill., November 9, 1900.

Colonel: In accordance with the instructions of the Board of Engineers, I have the honor to report upon the location of waterways for 7-foot and 8-foot navigation, with estimate of cost.

Under the terms of the act of March 3, 1899, these waterways are required for an extension of the navigation of Illinois River through the Upper Illinois and Lower Des Plaines to Lake Michigan at or near Chicago.

The Sanitary Canal having been opened in accordance with the State law and under a provisional permit from the Secretary of War, the flow of the Des Plaines and Illinois rivers has been increased by a discharge of 5,000 cubic feet per second, which will be raised to the maximum of 10,000 cubic feet per second under the provisions of the State law authorizing the construction of the Sanitary Canal.

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[1] Not reprinted; printed in House Doc. No. 112, Fifty-sixth Congress, second session.

As pointed out by the Board in its preliminary report of March 17, 1900, the steep slope from the controlling works at Lockport to the Joliet Basin precludes a slack-water system in this part of the river for waterways of 8 feet or less depth,

The Board decided upon a canal 100 feet wide at bottom from Lockport to the Joliet Basin, and from the Joliet Basin to the Illinois River just below the mouth of Kankakee River and locks 40 feet wide by 260 feet between miter sills, with fixed bridges giving 22 feet headroom.

From the mouth of Kankakee River to the La Salle pool in the Illinois River below Utica, the Board decided upon a slack-water system with a canal around the Marseilles Rapids, with locks of the same dimensions as those in operation on the Lower Illinois River, viz, 75 feet wide and 350 feet between miter sills.

The dimensions in this division are not less than 300 feet bottom width for river sections, and 170 feet surface width for canal. All bridges for this part of the line must be remodelled to suit the requirements of the lower-river traffic.

The 7 and 8 foot projects have been taken with the same levels for the water surface throughout. The depth in canal sections is taken 2 feet greater than the extreme low-water depths in the river, or deep enough for a boat to go through when loaded for a 2-foot stage. This gives a depth in the canal of 9 feet for the 7-foot project and 10 feet for the 8-foot project.

As the projects are for the extension of the navigation of the Illinois River to Chicago, the point of beginning is taken in the Illinois River at Utica, and the subdivisions are as follows:

RIVER DIVISION.

1. River from Utica to Marseilles.
2. Marseilles Canal.
3. River from head of Marseilles Canal to mouth of Kankakee River.

CANAL DIVISION.

1. Kankakee River to Joliet Basin.
2. Joliet Basin to Lockport.

Locks.—In accordance with the instructions of the Board, all masonry construction is taken as concrete with natural cement used in foundations and Portland cement throughout the rest of the work. The locks have been given uniformly foundation concrete 4 feet thick on bottoms, and the general section of the walls is taken as 5 feet wide on top and batter of 0.4 to the foot on the outer side. In estimating the cost of locks the cubic contents of the walls, bottoms, etc., were calculated. The rock excavation was also calculated from the area of the bottom and the general level of rock at that locality. The items of timber and iron, pumping and cofferdam, were taken in round numbers from the estimates of smaller locks in 1890, gates, valves, etc., and keepers' house from more recent cost of such constructions, and an assumed average for earth excavation and grading was made without specific location. The estimates of locks are as follows:

Estimate of locks, 7-foot project, river division.

[Locks 75 by 350 feet between miter sills.]

Location and character of locks.	Utica pool, rock foundations (lift, 15 feet; height of walls, 34 feet).		Marseilles Canal.					
			Lower lock, rock foundations (lift, 15 feet; height of walls, 27 feet).		Upper lock, rock foundations (lift, 15 feet; height of walls, 27 feet).		Guard lock, at head, rock foundations (height of walls, 20 feet).	
	Cubic yards.	Cost.	Cubic yards.	Cost.	Cubic yards.	Cost.	Cubic yards.	Cost.
Walls, etc., concrete, at $8	15,490	$123,920	11,228	$89,824	11,228	$89,824	6,606	$52,848
Bottom, concrete, at $5	7,549	37,745	7,189	35,945	7,189	35,945	6,809	34,045
Rock excavation, at $1.50	21,428	32,142	10,524	15,786	5,260	7,890	10,157	15,236
Timber and iron	....	20,000	....	19,000	....	19,000	....	18,000
Gates, valves, etc	....	46,000	....	42,000	....	42,000	....	40,000
Pumping and cofferdam	....	35,000	....	6,000	....	6,000	....	6,000
Earth excavation and grading	....	10,000	....	10,000	....	12,000	....	10,000
Keeper's house	....	3,000	....	3,000	....	3,000	....	3,000
Total cost	....	307,807	....	221,555	....	215,659	....	179,129

Estimate of locks, 7-foot project, canal division, Kankakee to Joliet Basin.

[Locks 40 by 260 feet between miter sills.]

Location and character of locks.	Lock at river (lift, 15 feet; height of walls, 27 feet).		Lock into Illinois and Michigan Canal (lift, 15 feet; height of walls, 27 feet).		Lock at Channahon (lift, 15 feet; height of walls, 27 feet).		Lock into Joliet Basin, rock foundations (lift, 9 to 15 feet; height of walls, 27 feet).	
	Cubic yards.	Cost.	Cubic yards.	Cost.	Cubic yards.	Cost.	Cubic yards.	Cost.
Walls, etc., concrete, at $8	7,322	$58,576	7,322	$58,576	7,322	$58,576	7,322	$58,576
Bottom, concrete, at $5	3,553	17,765	3,553	17,765	3,553	17,765	3,553	17,765
Rock excavation, at $1.50	....	....	....	....	....	....	6,232	9,348
Timber and iron	....	12,500	....	12,500	....	12,500	....	12,500
Gates, valves, etc	....	22,000	....	22,000	....	22,000	....	22,000
Pumping and cofferdam	....	12,000	....	5,000	....	5,000	....	12,000
Earth excavation and grading	....	17,500	....	19,500	....	19,500	....	6,000
Keeper's house	....	3,000	....	3,000	....	3,000	....	3,000
Total cost	....	143,341	....	138,341	....	138,341	....	141,189

Estimate of locks, 7-foot project, canal division, Joliet Basin to Lockport.

[Locks 40 by 260 feet between miter sills.]

Location and character of locks.	Lower lock, rock foundations (lift, 12 feet; height of walls, 24 feet).		Middle lock, rock foundations (lift, 12 feet; height of walls, 24 feet).		Upper lock, rock foundations (lift, 10 feet; height of walls, 22 feet).		Guard lock, at Lockport, rock foundations (lift, 0 to 10 feet; height of walls, 24 feet).	
	Cubic yards.	Cost.	Cubic yards.	Cost.	Cubic yards.	Cost.	Cubic yards.	Cost.
Walls, etc., concrete, at $8	6,130	$49,040	6,130	$49,040	5,428	$43,424	5,820	$46,560
Bottom, concrete, at $5	3,443	17,215	3,443	17,215	3,313	16,565	3,443	17,215
Rock excavation, at $1.50	6,255	9,382	8,025	12,037	8,938	13,407	7,132	10,698
Timber and iron	....	12,500	....	12,500	....	12,500	....	12,500
Gates, valves, etc	....	20,000	....	20,000	....	19,000	....	21,000
Pumping and cofferdam	....	5,000	....	5,000	....	5,000	....	5,000
Earth excavation and grading	....	6,000	....	6,000	....	6,000	....	6,000
Keeper's house	....	3,000	....	3,000	....	3,000	....	3,000
Total cost	....	122,137	....	124,792	....	118,896	....	121,973

Estimate of locks, 8-foot project, river division.

[Locks 75 by 350 feet between miter sills.]

Location and character of locks.	Utica Pool, rock foundations (lift, 15 feet; height of walls, 35 feet).		Marseilles Canal.					
			Lower lock, rock foundations (lift, 15 feet; height of walls, 28 feet).		Upper lock, rock foundations (lift, 15 feet; height of walls, 28 feet).		Guard lock, at head, rock foundations (height of walls, 21 feet).	
	Cubic yards.	Cost.	Cubic yards.	Cost.	Cubic yards.	Cost.	Cubic yards.	Cost.
Walls, etc., concrete, at $8	16,080	$128,640	11,730	$93,840	11,730	$93,840	7,020	$56,160
Bottom, concrete, at $5	7,600	38,000	7,240	36,200	7,240	36,200	6,860	34,300
Rock excavation, at $1.50	23,290	34,935	12,278	18,417	7,016	10,524	11,844	17,766
Timber and iron	....	20,000	....	19,000	....	19,000	....	18,000
Gates, valves, etc	....	48,000	....	45,000	....	45,000	....	43,000
Pumping and cofferdam	....	35,000	....	6,000	....	6,000	....	6,000
Earth excavation and grading	....	10,000	....	10,000	....	12,000	....	10,000
Keeper's house	....	3,000	....	3,000	....	3,000	....	3,000
Total cost	....	317,575	....	231,457	....	225,564	....	188,226

Estimate of locks, 8-foot project, canal division, Kankakee to Joliet Basin

[Locks 40 by 260 feet between miter sills.]

Location and character of locks.	Lock at river (lift, 15 feet; height walls, 28 feet).		Lock into Illinois and Michigan Canal (lift, 15 feet; height walls, 28 feet).		Lock at Channahon (lift, 15 feet; height walls, 28 feet).		Lock into Joliet Basin, rock foundation (lift, 9 to 15 feet; height walls, 28 feet).	
	Cubic yards.	Cost.	Cubic yards.	Cost.	Cubic yards.	Cost.	Cubic yards.	Cost.
Walls, etc., concrete, at $8	7,690	$61,520	7,690	$61,520	7,690	$61,520	7,690	$61,520
Bottom, concrete, at $5	3,590	17,950	3,590	17,950	3,590	17,950	3,590	17,950
Rock excavation, at $1.50	....	....	....	....	....	....	7,132	10,698
Timber and iron	....	12,500	....	12,500	....	12,500	....	12,500
Gates, valves, etc	....	24,000	....	24,000	....	24,000	....	24,000
Pumping and cofferdam	....	12,000	....	5,000	....	5,000	....	12,000
Earth excavation and grading	....	18,000	....	20,000	....	20,000	....	6,000
Keeper's house	....	3,000	....	3,000	....	3,000	....	3,000
Total cost	....	148,970	....	143,970	....	143,970	....	147,668

Estimate of locks, 8-foot project, canal division, Joliet Basin to Lockport.

[Locks 40 by 260 feet between miter sills.]

Location and character of locks.	Lower lock, rock foundations (lift, 12 feet; height walls, 25 feet).		Middle lock, rock foundations (lift, 12 feet; height walls, 25 feet).		Upper lock, rock foundations (lift, 10 feet; height walls, 23 feet).		Guard lock at Lockport, rock foundations (lift, 0 to 10 feet; height walls, 25 feet).	
	Cubic yards.	Cost.	Cubic yards.	Cost.	Cubic yards.	Cost.	Cubic yards.	Cost.
Walls, etc., concrete, at $8	6,470	$51,760	6,470	$51,760	5,750	$46,000	6,160	$49,280
Bottom, concrete, at $5	3,480	17,400	3,480	17,400	3,350	16,750	3,480	17,400
Rock excavation, at $1.50	7,130	10,695	8,900	13,350	9,790	14,685	8,007	12,010
Timber and iron	....	12,500	....	12,500	....	12,500	....	12,500
Gates, valves, etc	....	22,000	....	22,000	....	21,000	....	23,000
Pumping and cofferdam	....	5,000	....	5,000	....	5,000	....	5,000
Earth excavation and grading	....	6,000	....	6,000	....	6,000	....	6,000
Keeper's house	....	3,000	....	3,000	....	3,000	....	3,000
Total cost	....	128,355	....	131,010	....	124,935	....	128,190

The dams were taken as formed of concrete, 10 feet wide at top, upstream face vertical and downstream slope of 1 on 1. This was considered as enough to cover the cost of the work in whatever form it might be built, but not as a design for it. It is altogether possible that in the final plans crib dams here might be found to be the best construction. Details of the projects and estimates follow.

RIVER DIVISION.

Utica Level.—This consists of a lock and dam in the vicinity of Utica at river station 311½. The dam is between the south bank of the river and the middle island. It has a rock foundation and will be about 530 feet long. The dam is the same for both the 7 and 8 foot projects and is estimated as follows:

Concrete, 7,167 cubic yards, at $7	$50,169
Cofferdam	15,900
Pumping	10,000
Dam, total	76,069

Above this dam the north branch of the river will be cut off from the navigable route by a series of river walls and levees, thus giving a complete drainage to the wide bottom lands on the Utica side. The walls and levees are carried up to 2 feet above extreme high water and the costs for the 7 and 8 foot projects are the same.

The river walls are earth embankments 20 feet crown, slopes 3 on 1 on upstream side and 2 on 1 on downstream side, the upstream face to have a riprap 1 foot thick. These embankments are also to have core walls of rock-filled cribbing up to low water, topped with concrete walls 2 feet wide on top and batter of 0.3 to the foot on each side. Estimates are—

Concrete, 6,537 cubic yards, at $5	$32,687
Timber, 100.7 M, at $30	3,021
Rock filling, 2,527 cubic yards, at $1.50	3,790
Earth embankment, 64,887 cubic yards, at 20 cents	12,977
Riprap, 9,246 square yards, at 50 cents	4,623
Walls, total	57,098

The levees are taken as 20 feet crown, slopes 3 on 1 on river side and 2 on 1 on land side. Estimates are—

Earth embankment, 348,333 cubic yards, at 20 cents	$69,667

At the head of the Utica pool there is a rock excavation from about river station 256 to the foot of the Marseilles Canal at about river station 247½. Estimates are—

7-foot project, rock excavation, 29,300 cubic yards, at $2.50	$73,250
8-foot project, rock excavation, 84,050 cubic yards, at $2.50	210,125

MARSEILLES CANAL.

The lower level of this canal follows the river closely, with earth excavation on one side and fill on the other. The embankment on the river side will be made from the excavation, and is taken up to 2 feet above high water, and will be at least 30 feet wide on top, with side slope of 3 to 1 next the river. This river slope is to be covered with riprap, 1 foot thick. Estimates are:

7-foot project:	
Excavation, earth, 536,505 cubic yards, at 25 cents	$134,126
Riprap, 91,000 square yards, at 50 cents	45,500
Total	179,626
8-foot project:	
Excavation, earth, 587,495 cubic yards, at 25 cents	146,874
Riprap, 91,000 square yards, at 50 cents	45,500
Total	192,374

The upper level of the Marseilles Canal is in earth excavation up to about river station (218), where it passes into the side channel back of the island above Marseilles. This it follows to the head of the island (station 214), where it again goes into excavation up to about river station (210). Estimates are:

7-foot project excavation, earth, 1,249,315 cubic yards, at 25 cents	$312,329
8-foot project excavation, earth, 1,390,088 cubic yards, at 25 cents	347,522

The side channel back of the island above Marseilles into which the canal enters is closed at its upper and lower end by river walls, and these are joined by a levee protecting the island. Again, 2,000 feet of river wall is taken at the head of this canal division.

This levee and walls are all carried up to 2 feet above extreme high water. The construction is the same as the levees and river walls in the Utica division, except that the embankments in the river walls here are taken as made from the excess of excavation in which they are estimated. The cost of these walls and levee are the same for both the 7 and 8 foot projects. Estimates are:

Walls:	
Concrete, 10,268 cubic yards, at $5	$51,340
Timber, 763.7 M, at $30	22,911
Rock filling, 12,463 cubic yards, at $1.50	18,695
Riprap, 24,672 square yards, at 50 cents	12,336
Total	105,282
Levee, earth embankment, 82,051 cubic yards, at 20 cents	16,410

KANKAKEE POOL.

This pool is formed by a dam at about river station (210), raising the low water of the river to that of the upper level of the Marseilles Canal. This dam is 730 feet long, on a rock foundation, and its cost is the same for both the 7 and 8 foot projects. Estimates are—

Concrete, 11,717 cubic yards, at $7	$82,019
Cofferdam	21,900
Pumping	10,000
Total	113,919

At the head of this pool at about river station (150) up to river station (96) an earth excavation in the river is required. Estimates are—

7-foot project, excavation, earth, 261,500 cubic yards, at 25 cents	$65,375
8-foot project, excavation, earth, 624,100 cubic yards, at 25 cents	156,025

CANAL DIVISION.

Kankakee Pool to Joliet Basin.—From the head of the Kankakee Pool the waterway leaves the river and is carried up in a short section of canal with two locks of 15-feet lift each and enters the Illinois and Michigan Canal. From there up to the Joliet Basin the section of this old canal is simply enlarged to the required dimensions. Estimates are—

7-foot project:	
Excavation, earth, 1,608,375 cubic yards, at 25 cents	$402,094
Excavation, rock, dry, 51,732 cubic yards, at $1.50	77,598
Excavation, total	479,692
8-foot project:	
Excavation, earth, 1,413,706 cubic yards, at 25 cents	353,426
Excavation, rock, dry, 519,251 cubic yards, at $1.50	778,876
Excavation, total	1,132,302

The old Illinois and Michigan Canal now crosses the DuPage River at Channahon in a pool, with a guard lock below, and rises to the Joliet level in a lock just above it. It is thought that the better construction will be to take all the lift here below the DuPage and cross that river in an aqueduct. The cost of this has been approximately estimated at $100,000 for the 7-foot project and $105,000 for the 8-foot project. There will be also required on this line 3 culverts, which will be about the same cost in both projects, and are taken at $25,000 each, or a total of $75,000.

Joliet basin to sanitary canal at Lockport.—From Joliet up to Lockport the canal is approximately half of its depth in excavation and held in in retaining walls, with the excavation used for backing. The excavation in this division is all rock. Estimates are—

7-foot project, excavation rock (dry), 156,450 cubic yards, at $1.50	$234,675
8-foot project, excavation rock (dry), 218,396 cubic yards, at $1.50	327,594

The retaining walls are taken as concrete masonry 6 feet wide, and the cost is the same in both projects. Estimates are—

Concrete, 92,950 cubic yards, at $5	$464,750

In addition three culverts will be required for this line, which are approximately the same in both projects and have been taken at $25,000 each, or a total of $75,000.

BRIDGES.

The cost of changing the bridges on this line to meet the requirements of the proposed waterway is the same for both projects. A list of the bridges, with estimates, follows:

Bridges for 7 and 8 foot waterways.

Character.	No. of tracks.	Location.
RIVER DIVISION.		
Highway		Peru.
Do		Lasalle.
Railroad	1	Do.
Do	1	Do.
Highway		Utica.
Railroad	1	Ottawa.
Highway		Do.
Do		Marseilles.
Do		Seneca.
Do		Morris.
Railroad	1	Seneca.
CANAL DIVISION.		
Railroad	1	E. J. and E.
Highway		Near E. J. and E.
Do		Channahon.
Do		Bird's Bridge.
Do		
Do		Brandon's.
Do		Joliet.
Railroad	2	Do.
Street		Jefferson street, Joliet.
Do		Cass street, Joliet.
Do		Jackson street, Joliet.
Do		Joliet.
Railroad	1	E. J. and E. above Joliet.
Highway		Lockport.
Do		Ninth street, Lockport.

RIVER DIVISION—SWING BRIDGES.

4 single-track railroad, hand power, at $60,000	$240,000	
7 highway, hand power, at 25,000	175,000	
		$415,000

CANAL DIVISION.

[Fixed bridges 22 feet clear headroom.]

1 double-track railroad, at $60,000	$60,000	
2 single-track railroad, at 35,000	70,000	
4 street bridges (Joliet), at 50,000	200,000	
8 highway, at 15,000	120,000	
		450,000
		865,000

LAND DAMAGES.

Estimates for rights of way and land damages were taken approximately at $700,000. Estimates of flooded land values were made here by the Sanitary District of Chicago in 1892, but their prices seemed too low for present land values, and the round sum taken here considers them increased about 50 per cent.

Very respectfully, your obedient servant,

James A. Seddon,
Assistant Engineer.

Col. J. W. Barlow,
Corps of Engineers, U. S. Army,
President Board of Engineers, Chicago, Ill.

M M 9.

PRELIMINARY EXAMINATION OF ILLINOIS AND DES PLAINES RIVERS, ILLINOIS, WITH A VIEW TO THE EXTENSION OF NAVIGATION TO LAKE MICHIGAN, AT OR NEAR CHICAGO, WITH CHANNEL DEPTHS OF 10, 12, AND 14 FEET.

[Printed in House Doc. No. 220, Fifty-sixth Congress, second session.]

Office of the Chief of Engineers, U. S. Army,
Washington, December 15, 1900.

Sir: The emergency river and harbor act approved June 6, 1900, contained the following provision:

> Upper Illinois River and Des Plaines River: That the board of three engineers, appointed by the Secretary of War, in pursuance of a paragraph in the river and

harbor Act approved March third, eighteen hundred and ninety-nine, to make a survey and estimates of cost of the improvement of the Upper Illinois River and the lower Des Plaines River in Illinois, with a view to the extension of navigation from the Illinois River to Lake Michigan at or near the city of Chicago, is hereby authorized to report the estimates of cost for a channel ten feet deep, and for a channel twelve feet deep, and for a channel fourteen feet deep through said proposed route, and that the said estimates cover and include a proper connection at Lockport with the sanitary and ship canal which has been constructed by the sanitary district of Chicago. The said board of engineers is also further authorized to make a survey and estimate of cost for the improvement of the Lower Illinois River from the end of said proposed route to the mouth of said river, for channels ten, twelve, and fourteen feet deep, respectively, and to report the estimates of cost thereof: *And provided further*, That surveys and estimates of cost shall be made in pursuance of the provisions contained in the Act aforesaid, and especially in accordance with section twenty-two of said Act: *And provided further*, That said surveys shall be commenced and the expenses for said surveys and reports shall be paid as follows: Any unexpended balance of the appropriation of thirty thousand dollars not required for the completion of the survey already contained in said Act shall be first applied and used, and no further expense shall be incurred for such estimates and surveys without the further direction of Congress, and the Secretary of War shall ascertain and report to Congress what amount of money shall be required to complete said surveys and estimates of costs.

The Board of Engineers referred to was promptly advised of the additional duties required of them by the terms of the law above quoted, and I now have the honor to submit, with a view to its transmission to Congress, the accompanying copy of the Board's report on the subject, dated November 18, 1900.

The conclusions of the Board are as follows:

(1) That the existing project for the improvement of the Lower Illinois River, if extended to Lake Michigan by the 8-foot project along the Upper Illinois and Des Plaines rivers, on which the Board has submitted estimates, is ample for all the existing river navigation in the Mississippi Valley or any improvement thereof authorized by Congress.

(2) That any extension of lake navigation inland along the Des Plaines and Illinois rivers will require a navigable waterway not less than 14 feet in depth.

(3) The cost of such a channel is not likely to fall short of $30,000,000.

(4) That a waterway for lake vessels extending only to the mouth of the Illinois will not develop a commerce that will justify such an expenditure, and that this improvement by itself is not advisable.

The Board therefore recommends that no further surveys of the Des Plaines and Illinois rivers be made unless in connection with a project to be authorized by Congress which shall include provision for a corresponding depth of water in the Mississippi River below the mouth of the Illinois.

The report, dated November 17, 1900, by the Board upon the 7-foot and 8-foot projects, as provided for by the act of March 3, 1899, is now before Congress and is printed as House Doc. No. 112, Fifty-sixth Congress, second session.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

Hon. ELIHU ROOT,
Secretary of War.

REPORT OF BOARD OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., November 18, 1900.

GENERAL: The river and harbor act approved June 6, 1900, provides—

That the board of three engineers appointed by the Secretary of War, in pursuance of a paragraph in the river and harbor Act approved March third, eighteen hundred and ninety-nine, to make a survey and estimates of cost of the improvement of the Upper

Illinois River and the lower Des Plaines River in Illinois, with a view to the extension of navigation from the Illinois River to Lake Michigan at or near the city of Chicago, is hereby authorized to report the estimates of cost for a channel ten feet deep, and for a channel twelve feet deep, and for a channel fourteen feet deep through said proposed route, and that the said estimates cover and include a proper connection at Lockport with the sanitary and ship canal which has been constructed by the sanitary district of Chicago. The said board of engineers is also further authorized to make a survey and estimate of cost for the improvement of the Lower Illinois River from the end of said proposed route to the mouth of said river, for channels ten, twelve, and fourteen feet deep, respectively, and to report the estimates of cost thereof: *And provided further*, That surveys and estimates of cost shall be made in pursuance of the provisions contained in the Act aforesaid and especially in accordance with section twenty-two of said Act: *And provided further*, That said surveys shall be commenced and the expenses for said surveys and reports shall be paid as follows: Any unexpended balance of the appropriation of thirty thousand dollars not required for the completion of the survey already contained in said Act shall be first applied and used, and no further expense shall be incurred for such estimates and surveys without the further direction of Congress, and the Secretary of War shall ascertain and report to Congress what amount of money shall be required to complete said surveys and estimates of cost.

In compliance with your instructions in accordance therewith, contained in Department letter dated June 11, 1900, the Board has the honor to submit the following preliminary report:

Section 22 of the river and harbor act approved March 3, 1899, under which surveys and estimates are to be made, is as follows:

> That the Secretary of War is hereby directed to cause preliminary examinations or surveys to be made at the localities named in this section as hereinafter provided. In all cases a preliminary examination shall first be made, which shall embrace information concerning the commercial importance, present and prospective, of the river or harbor mentioned, and a report as to the advisability of its improvement. Whenever such preliminary examination has been made, in case such improvement is not deemed advisable, no further action shall be taken thereon without the direction of Congress; but in case the report has been or shall be to the effect that such river or harbor is worthy of improvement, the Secretary of War is hereby directed at his discretion, to cause surveys to be made and the cost of improving such river or harbor to be estimated and to be reported to Congress.

It therefore devolves upon the Board to express its opinion as to the advisability of the improvement before surveys can be undertaken. As Congress has approved the project for the improvement of the Illinois River from its mouth to Lasalle, providing for a depth at low water of 7 feet, and authorized surveys to determine the cost of obtaining waterways with depths of 7 and 8 feet from Lasalle to Lake Michigan, at or near Chicago, upon which we have submitted a report dated November 17, 1900, the question now before the Board is the advisability of a further enlargement of this waterway to depths of 10, 12, and 14 feet.

The preliminary examination of the Lower Illinois River from Grafton to Peru was made by members of the Board on the steamer *Reindeer*, chartered for the purpose August 2 to 4, 1900. The Board had also examined the portions of the route from the end of the drainage canal at Lockport to the mouth of the Des Plaines River and the rapids at Marseilles, in connection with the survey for determining the cost of the 7 and 8 foot waterways along the Upper Illinois and Des Plaines rivers.

The present commerce of the Lower Illinois River practically all terminates at St. Louis, and the traffic of the river is represented by the Illinois River freight received and shipped at that point. There is appended a statement of the receipts and shipments at St. Louis of Illinois River freight for the past eight years, derived from the reports of the Merchants' Exchange of St. Louis. This commerce averages 44,425 tons per annum. (Appendix 1.)

While the Upper Illinois and Des Plaines rivers are at present non-navigable, the commerce of the Illinois and Michigan Canal which has been constructed in the valleys of these rivers may be taken to represent the present commerce of such a route. The tonnage carried on the Illinois and Michigan Canal since 1860, derived from the reports of the Board of Trade of Chicago, is also appended. (Appendix 2.)

To determine the prospective commercial importance of the proposed route an expression of opinion was invited from those interested, who had made the matter a subject of special study. There accompany this report the papers submitted:[1]

A. Memoir of the trustees of the sanitary district of Chicago.

B. Commercial utility of a waterway of a navigable depth of not less than 14 feet between Chicago and St. Louis; brief by Lyman E. Cooley.

C. Paper on a deep waterway from the Great Lakes to the Gulf of Mexico, presented by the Illinois River Valley Association.

The commerce of the waterways of the Illinois and Des Plaines valleys is small and has been diminishing in recent years. It is not sufficient to warrant any increase in existing navigable depths, and it is only by considering the development of a connecting link between the system of river commerce in the Mississippi Valley on the one hand and the commerce of the Great Lakes on the other that even a waterway with a depth of 8 feet will be justified.

The adopted projects for the improvement of the Mississippi River provide from the mouth of the Illinois River to the mouth of the Missouri "for a channel of a depth of 4½ feet at low water, to be eventually increased to 6 feet;" from the mouth of the Missouri River to St. Louis "eventually a minimum depth at standard low water of 6 feet, and of 8 feet from St. Louis to the mouth of the Ohio," and below the mouth of the Ohio 10 feet at low water. The projects for the improvement of all the tributaries of the Mississippi, except the Illinois River, provide for waterways of not exceeding 6 feet at low water.

The project for the Lower Illinois River provides for locks 75 feet wide and 350 feet between miter sills, with 7 feet on the miter sills at low water. The discharge of the Chicago Drainage Canal should increase the navigable depth to over 8 feet, and if the project be extended to Lake Michigan by the 8-foot project on which estimates have been submitted by the Board, there will be afforded a connecting link between the Great Lakes and the rivers of the Mississippi Valley, not only ample for river navigation as it now exists, but also for any improvement therein that has been authorized by Congress.

But it is held by not a few that the United States should take the initiative and construct a great waterway of which the Illinois Valley line should be a link, extending lake navigation to the interior of the country, and that a commerce which does not now exist will then develop to such magnitude as will more than justify the expenditure. For such a project a depth of 14 feet or greater will be required, and further surveys and estimates for a waterway of less depth than 14 feet can not be considered by the terms of section 22, under which the Board is instructed to act.

The engineering questions presented in a project for a deep waterway to connect Lake Michigan with the Illinois River, although attended with considerable difficulty, are by no means insuperable. The proposed line would embrace, first, the Chicago River, consisting of the main river and a portion of the South Branch for a distance of about 5 miles. This section is now under improvement by the United States in cooperation with the trustees of the sanitary district of Chicago, and will, when the many changes in bridges and tunnels have been made, and the widening and deepening of the channel completed, afford a navigable depth of 21 feet and an available width of 200 feet.

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[1] Not printed.

Connecting with this section the sanitary canal affords a magnificent waterway, 28 miles in length, of sufficient depth and width for any possible requirement of navigation.

From the west end of this canal the waters of Lake Michigan, in a steady flow amounting to from 5,000 to 10,000 cubic feet per second, are discharged into the bed of the Des Plaines River, and are carried thence down through the Illinois to the Mississippi.

The velocity of current along the Des Plaines River, which would have resulted from confining this discharge to a channel of 8 feet depth for barge navigation, will be sufficiently reduced in a ship canal of 14 feet depth or over to make upstream navigation feasible. On the Lower Illinois River the prevailing slope of less than 0.15 foot per mile will insure so gentle a current that the depth required can be secured simply by enlarging the existing waterway by dredging in an alluvial deposit, at a cost which will be small when compared with the work which has been done by the city of Chicago in cutting through the divide between the lake basin and the Illinois Valley watershed, so eloquently described in the memoir of the board of trustees of the sanitary district of Chicago.

But such a channel to be of commercial value should either form a through line of communication between the lakes and the Gulf of Mexico or extend to some large center of population, as St. Louis. A waterway stopping at the village of Grafton would have little commercial importance, except locally, over one to the present terminus of the drainage canal at Lockport. The terminal arbitrary described by Mr. Cooley in his paper submitted will be as applicable in the one case as in the other.

The commercial possibilities of navigation by lake vessels to St. Louis and the Gulf of Mexico have been ably discussed in the papers accompanying this report, but all of these projects are based upon the assumption that the Mississippi River can be rendered navigable for such vessels. The feasibility of the development of the navigation of the Mississippi River is the essential element, which must first be determined before any project for extending lake navigation inland can be considered advisable.

In the papers on "A deep waterway from the Great Lakes to the Gulf of Mexico," submitted by the Illinois River Valley Association, are various suggestions for obtaining 14 and 20 foot navigation in the Mississippi River. There are proposed the construction of immense dams in the alluvial bed of the river, the flooding of tracts of country of an area greater than that of several of the States of the Union, and other schemes of great boldness and originality of design.

The Board does not feel called upon to consider these projects, but in their discussion by eminent engineers it is indicated that the development of a navigable waterway of great depth in the Mississippi River, with its steep slopes and shifting sand bars, presents far greater difficulties from an engineering standpoint than does the improvement of the Illinois and Des Plaines rivers.

Nor has the Board been able to collect information upon which it can safely base predictions upon the character or amount of the commerce likely to seek such a great waterway, or be developed by it should it be provided. It, however, invites attention to the memoir of the trustees of the sanitary drainage canal and to the comprehensive paper of the Hon. L. E. Cooley, civil engineer, upon the commercial utility of the proposed waterway.

Of the appropriation of $30,000 for surveys, $25,200 has been applied to surveys for the 7-foot and 8-foot projects. The unexpended balance is not sufficient to serve any useful purpose in the survey for determining the cost of waterways 10, 12, and 14 feet deep in the Des Plaines and Illinois rivers. It is estimated that such a survey will cost not less than $200,000, as it should include a survey of the entire valley subject to overflow, with numerous borings in the vicinity of the proposed masonry structures. From the data available from the survey for the 7 and 8 foot projects, the Board submits the following preliminary estimates for a 14-foot waterway for lake vessels. If this waterway is to have a commerce commensurate with its cost, locks should be provided with dimensions at least equal to those of the Weitzel Lock at the Sault Ste. Marie Canal. Provision is therefore made for locks 80 feet by 600 feet:

Estimates.

Utica Pool:		
Dam and movable weir	$106,000	
Lock	667,838	
Levees	173,814	
River walls	92,844	
Rock excavation	1,191,812	
		$2,232,308
Marseilles Canal:		
2 locks	1,019,887	
Levees	19,896	
River walls	20,514	
Earth excavation	477,565	
		1,537,862
Morris Pool:		
Dam and movable weir	146,000	
Earth excavation	875,179	
		1,021,179
Kankakee Pool:		
Dam and movable weir	140,000	
1 lock	603,582	
Earth excavation	352,241	
Rock excavation	1,447,250	
		2,543,073
Lower Joliet Pool:		
Dam and movable weir	140,000	
2 locks	1,160,441	
Rock excavation	1,994,497	
		3,294,938
Canal, Joliet Basin to Lockport:		
3 locks	1,411,143	
Rock excavation	2,217,552	
River walls	414,624	
Culverts	100,000	
		4,143,319
Bridges		1,300,000
Right of way		1,000,000
Engineering and contingencies, 20 per cent		3,414,536
Total		20,487,215

This preliminary estimate should be increased by about $8,000,000, to cover the cost of dredging some 75,000,000 cubic yards from the bed of the river to extend the 14-foot waterway from Utica to the mouth of the Illinois River, and to provide the necessary piers and spans of all highway and railway bridges across the navigable channel.

After carefully considering all available information the Board has arrived at the following conclusions:

(1) That the existing project for the improvement of the Lower Illinois River, if extended to Lake Michigan by the 8-foot project along the Upper Illinois and Des Plaines rivers, on which the Board has submitted estimates, is ample for all the existing river navigation in the Mississippi Valley, or any improvement thereof authorized by Congress.

(2) That any extension of lake navigation inland along the Des Plaines and Illinois rivers will require a navigable waterway not less than 14 feet in depth.

(3) The cost of such a channel is not likely to fall short of $30,000,000.

(4) That a waterway for lake vessels extending only to the mouth of the Illinois will not develop a commerce that will justify such an expenditure, and that this improvement by itself is not advisable.

The Board therefore recommends that no further surveys of the Des Plaines and Illinois rivers be made unless in connection with a project to be authorized by Congress which shall include provision for a corresponding depth of water in the Mississippi River below the mouth of the Illinois.

Respectfully submitted.

J. W. Barlow,
Colonel, Corps of Engineers.
J. H. Willard,
Major, Corps of Engineers.
C. McD. Townsend,
Major, Corps of Engineers.

Brig. Gen. John M. Wilson,
Chief of Engineers, U. S. A.

Appendix 1.

Illinois River tonnage at St. Louis, Mo., for eight years.

[From reports of St. Louis Merchants' Exchange.]

Year.	Receipts.	Shipments.	Total.
1899	32,585	9,090	41,675
1898	20,415	8,828	29,243
1897	38,130	7,065	45,195
1896	30,325	11,780	42,105
1895	30,600	7,040	37,640
1894	41,380	4,495	45,875
1893	50,605	5,785	56,390
1892	49,520	7,755	57,275
Average	36,695	7,730	44,425

APPENDIX 2.

ILLINOIS AND MICHIGAN CANAL.

Number of canal boats running, of clearances issued, and of tons transported on the Illinois and Michigan Canal from 1860 to 1898, inclusive.

Year.	Clearances issued.	Boats running.	Miles run.	Tons transported.
1860	3,926	201	235,684	367,437
1861	6,339	194	415,599	547,295
1862	7,044	211	474,976	673,590
1863	5,810	240	418,713	619,599
1864	4,527	228	300,340	510,286
1865	3,907	228	360,614	616,140
1866	5,488	230	406,784	746,815
1867	4,183	209	357,623	746,954
1868	4,128	218	345,169	737,827
1869	4,524	219	285,050	871,738
1870	2,903	179	242,650	585,870
1871	3,523	186	278,948	629,975
1872	[1]5,018	173	334,820	783,641
1873	[1]4,743	172	328,164	849,588
1874	[1]4,296	152	288,075	712,020
1875	[1]3,554	142	259,878	676,025
1876	[1]4,049	145	302,024	691,943
1877	[1]4,008	145	272,788	605,912
1878	[1]4,299	140	293,335	598,792
1879	[1]4,458	136	304,191	669,559
1880	[1]4,536	133	320,009	751,360
1881	[1]4,459	133	316,435	826,133
1882	[1]4,055	132	335,710	1,011,287
1883	[1]3,789	132	306,618	925,575
1884	[1]4,204	134	325,431	956,721
1885	[1]3,990	135	304,664	827,355
1886	[1]3,783	130	303,575	808,019
1887	[1]3,824	132	290,338	742,074
1888	[1]3,326	127	267,771	751,005
1889	[1]4,299	114	334,107	917,047
1890	[1]2,920	104	260,713	742,392
1891	[1]3,203	97	243,214	641,156
1892	[1]3,014	95	260,149	783,288
1893	[1]2,452	82	187,905	529,816
1894	[1]2,907	81	206,875	617,811
1895	[1]2,904	78	196,132	591,407
1896	[1]2,660	67	167,289	446,762
1897	[1]4,151	64	179,954	484,575
1898	[1]3,523	64	152,960	395,017

[1] Includes clearances at Henry and Copperas Creek.

Receipts, by months, from December 1, 1898, to November 30, 1899.

	Dec.	Jan.	Feb.	Mar.	Apr.	May.
Barley .... pounds..	66,815	....	....	....	....	....
Corn .... bushels..	10,675	3,671	20,413	4,963	63,100	45,400
Flour .... sacks..	2,171	160	910	110,870	3,548	13,428
Do .... barrels..	1,055	11	....	2,130	750	6,463
Meal .... pounds..	250,000	....	....	23,000	12,000	1,040,500
Oats .... bushels..	21,622	....	....	21,341	57,000	108,640
Rye .... do....	2,727	....	....	....	....	....
Wheat .... do....	....	....	....	....	....	....
Hay .... tons..	....	....	....	....	....	47.5
Straw .... do....	....	....	....	....	....	....
Stone (rubble) .... cubic yards..	270	....	....	4,731	12,986	15,444
Stone (dimension) .... do....	19	....	....	....	1,667	3,854
Stone (riprap)	6,662	....	....	2,223	3,802	4,899
Boats .... number miles..	3,987	232	819	3,922	10,261	13,959

Receipts, by months, from December 1, 1898, to November 30, 1899—Continued.

	June.	July.	Aug.	Sept.	Oct.	Nov.
Barley .... pounds..	....	....	....	....	....	66,816
Corn .... bushels..	115,498	112,472	134,800	475,827	343,890	78,900
Flour .... sacks..	8,799	6,105	9,954	8,123	4,797	81,647
Do .... barrels..	3,915	3,421	5,180	5,812	5,840	87,244
Meal .... pounds..	1,232,000	580,000	625,000	1,073,000	620,000	....
Oats .... bushels..	48,663	5,168	47,643	13,000	16,171	11,553
Rye .... do....	....	....	....	....	....	....
Wheat .... do....	....	....	....	....	....	....
Hay .... tons..	374	287	....	....	....	....
Straw .... do....	....	....	....	....	....	....
Stone (rubble) .... cubic yards..	21,163	11,034	12,720	10,284	6,232	6,769
Stone (dimension) .... do....	2,699	2,583	2,981	3,188	1,962	511
Stone (riprap)	6,010	4,009	8,473	5,488	7,617	6,785
Boats .... number miles..	15,755	12,428	15,463	16,817	14,015	10,056

Shipments, by months, from December 1, 1898, to November 30, 1899.

	Dec.	Jan.	Feb.	Mar.	Apr.	May.
Corn .... bushels..	2,760	6,539	25,066	5,791	....	5,932
Wheat .... do....	116,868	39,572	32,404	105,680	36,242	90,687
Lumber .... feet..	14,100	....	....	27,913	7,536	824,410
Shingles .... M..	....	....	....	....	20	114
Lath .... M..	....	....	....	....	....	....
Merchandise .... pounds..	23,400	1,100	9,000	19,400	11,900	37,900

	June.	July.	Aug.	Sept.	Oct.	Nov.
Corn .... bushels..	23,830	14,460	962	31,643	9,210	5,000
Wheat .... do....	52,055	99,086	69,909	99,214	63,884	90,751
Lumber .... feet..	249,694	423,731	193,974	404,543	30,591	41,290
Shingles .... M..	55	12	40	90	67	20
Lath .... M..	25	110	20	....	2	....
Merchandise .... pounds..	17,550	29,600	26,100	35,000	38,150	29,250

M M 10.

PRELIMINARY EXAMINATION OF ROCK RIVER, ILLINOIS, AT THE HEAD OF THE FEEDER FOR THE ILLINOIS AND MISSISSIPPI CANAL WITH A VIEW TO THE CONSTRUCTION OF A LOCK AND DAM IN THE RIVER IN CONNECTION WITH SAID CANAL.

[Printed in House Doc. No. 126, Fifty-sixth Congress, second session.]

Office of the Chief of Engineers,
United States Army,
Washington, November 30, 1900.

Sir: I have the honor to submit herewith for transmission to Congress copy of report dated October 19, 1900, by Maj. J. H. Willard, Corps of Engineers, upon preliminary examination authorized by the emergency river and harbor act approved June 6, 1900, as follows:

> **Rock River, at the head of the feeder for the Illinois and Mississippi Canal** [Illinois]: **With a view to the construction of a lock and a dam in Rock River** in connection with **said canal.**

The dam in Rock River referred to is already provided for in connection with the feeder line for the Illinois and Mississippi Canal now being constructed under the continuing-contract system, and the insertion of a lock in the dam is desired by the citizens of the cities of Sterling and Rockfalls, with a view to extending the navigation that may take place through the canal and over that portion of the river above the dam down to and along the river fronts of the business portions of both cities. In the opinion of the local officer the work is worthy of being undertaken by the United States, and an estimate of its cost is submitted, amounting to $75,000. Further surveys are not necessary at this time.

In view of the fact that the proposed work is so closely identified with that of the canal and feeder line now under way, I would respectfully recommend that, if the improvement be authorized by Congress, the project and estimate for the Illinois and Mississippi Canal be extended to include the additional features now presented, rather than that they be treated as a separate and distinct project.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army

Hon. ELIHU ROOT,
Secretary of War.

REPORT OF MAJ. J. H. WILLARD, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., October 19, 1900.

GENERAL: I have the honor to submit report upon the preliminary examination of "Rock River, at the head of the feeder for the Illinois and Mississippi Canal [Illinois]: With a view to the construction of a lock and dam in Rock River in connection with said canal," required by the act of June 6, 1900.

I have made personal examination of the site, and have had additions made to previous surveys by Assistant Engineer L. L. Wheeler, resident engineer of the canal and feeder, whose report, with appendixes and maps,[1] is sent herewith.

The dam has already been located and the flowage damages paid under the decree of the United States court. The decree requires the dam to be of some movable type to provide for flood discharges.

The introduction of a lock in the dam will require a reduction in the level of the sills of the foundations or fixed portions of the dam to provide equivalent discharge section.

The form of movable dam has not been decided, but preliminary study indicates the Boulé gate with movable trestles, and Taintor gates for the regulating sluiceways, one of which should be placed so as to flush the river channel. No estimates are submitted for the dam, as it is provided for in the estimates for the canal feeder.

The lock should be of the same dimensions as for the canal proper, although the depth in the pool below can not be made greater than 5 feet below the crest of the power dam except by excavating the pool or by raising the crest of the power dam.

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[1] Not reprinted: printed in House Doc. No. 126, Fifty-sixth Congress, second session.

I could not recommend the latter under any circumstances, for it would mean a partnership in which the United States would bear all the expenses of construction and operation of the dam, the cost of remodelling the buildings and power plants, raising or reconstructing the bridges, and all expenses incident to such changes, and new claims for flowage damages in the lower pool. The power company has put up flashboards to raise the pool about 18 inches for its own service, and may continue to do so, assuming that it has the right, after the canal dam has been built.

Five feet depth would seem to be sufficient for present needs, and if a greater depth should be warranted by the development of river and canal traffic it would be less expensive to obtain it by excavating the bed of the river.

But the canal in the pool below the movable dam should be excavated to at least 7 feet depth below the crest of the power dam, and this will be necessary in any case to provide sufficient rock for the river dike.

I think it would be advisable to remove loose rock and bowlders from the pool between the banks below the end of the dike to give a reasonable pool area of 5 feet depth.

The examination has not been extended further than necessary for preliminary report, and therefore no definite estimate can be submitted for such additional work, but as the project is, in my opinion, worthy to be undertaken by the United States, I increase the estimate of Assistant Engineer Wheeler to $75,000. No further examination or surveys are necessary at the present time.

Very respectfully, your obedient servant,

J. H. WILLARD,
Major, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, NORTHWEST DIVISION,
New York, October 29, 1900.

Respectfully forwarded to the Chief of Engineers, U. S. Army, concurring in the views of the district engineer that this locality is worthy of improvement by the United States.

* * * * * * *

J. W. BARLOW,
Colonel, Corps of Engineers,
Division Engineer.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
October 30, 1900.

Respectfully submitted to the Secretary of War.

In submitting the within report of a preliminary examination provided for by the emergency river and harbor act of June 6, 1900, of

Rock River at the head of the feeder for the Illinois and Mississippi Canal, with a view to the construction of a lock and dam in Rock River in connection with said canal, the local engineer, Major Willard, states the project is worthy to be undertaken by the United States and that no further examination or surveys are necessary at this time; he estimates that the work proposed will cost $75,000.

The division engineer, Colonel Barlow, concurs in the views of Major Willard, and I recommend that action of the local officer, in including in the report of the examination the estimate of the cost of the proposed work, be approved.

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

[Third indorsement.]

WAR DEPARTMENT,
November 2, 1900.

Approved as recommended by the Chief of Engineers.

By order of the Secretary of War:

JOHN C. SCOFIELD,
Chief Clerk.

REPORT OF MR. L. L. WHEELER, ASSISTANT ENGINEER.

STERLING, ILL., *October 17, 1900.*

MAJOR: I have the honor to submit the following report on examinations and estimate of cost of placing a lock in the proposed dam across Rock River at the head of the feeder for the Illinois and Mississippi Canal, as called for in river and harbor act of June 6, 1900:

The proposed dam is located at the upper end of the rapids in Rock River at Sterling, Ill., while at the lower end is located the dam of the Sterling Hydraulic Company. The city of Sterling owns a wagon bridge across the river a short distance above the Hydraulic Company's dam and the Chicago, Burlington and Quincy Railroad Company has a railway bridge a short distance above the wagon bridge. The city of Sterling is situated on the north bank of the river and the city of Rockfalls on the south bank. The combined population of the two cities is about 12,000.

The bed of the river at the site of the proposed dam is smooth rock, the depth of water varying from 6 inches to 18 inches at low water. The rock bed dips downstream so that a depth of 5 feet is reached a short distance above the railroad bridge. The banks are from 20 to 25 feet high, being rock overlaid with from 4 to 6 feet of earth. The extreme low-water flow of the river is about 700 cubic feet per second, and the high-water flow about 35,000 cubic feet per second. Ordinary low-water flow is about 2,000 cubic feet per second.

The dam for the feeder will raise the water to grade 208.3 Hennepin datum, the low-water elevation at the same point before the Hydraulic Company's dam was rebuilt being 198.3. The Hydraulic Company's dam was rebuilt in 1895 and raised the water surface at low water above the rapids nearly one-half foot. The damages to the lands above the proposed dam were awarded under a decree of the United States district court which requires the dam to have in it and forming part of it 168 linear feet of sluiceways and 1,040 linear feet of movable dam, with sill 4 feet below the normal level of the pool. The insertion of a lock in the dam may render necessary some slight changes in the proportions of the sluiceways and movable dam.

The feeder leaves Rock River at the eastern limits of Rockfalls, and on neither side of the river above the proposed dam can suitable facilities be obtained for transferring freight to and from boats navigating the canal and river. On the north side of the river the Chicago and Northwestern Railway tracks are along the top of the bluff with no room for landings or warehouses. On the south side of the river a large area of submerged land will be between the navigable channel of the river and the main bank. The site of the proposed dam is entirely above the business portion of both cities. This survey and estimate of cost was asked for by the citizens of the two cities with a view to extending the navigation that may take place through the canal and over that portion of the river above the dam down to and along the river fronts of the business portions of both cities.

The dimensions of the Illinois and Mississippi Canal and of its feeder provide for a width at water line of 80 feet, a depth of 7 feet, and a clear headroom beneath fixed obstructions of 17 feet. In preparing a project for connecting this waterway with the pool above the Hydraulic Company's dam it is necessary to take into consideration the limiting conditions imposed by natural and artificial obstructions. The depth of water in the pool would not permit a navigable depth of 7 feet over any considerable area, and above the railway bridge boats drawing 5 feet would be restricted to a very small area adjacent to the bridge. There is a clear height under the wagon bridge of 12 feet and under the railway bridge of 17.5 feet above the crest of the Hydraulic Company's dam. The depth in the pool therefore can not be increased by raising the crest of the Hydraulic Company's dam except that the bridges also be raised. The railway bridge can not be raised without introducing expensive changes in the system of tracks, both for the Chicago, Burlington and Quincy Railroad Company and the Chicago and Northwestern Railway Company. The crossing at the north end of the bridge is interlocked and is at the eastern limit of yards for both railroads. The depot and yards for Rockfalls are near the south end of the bridge. The wagon bridge could be raised so as to give 17 feet clearance above the crest of the present dam, but any further increase in height would introduce difficulties and expense in crossing the numerous railway tracks near the north end of the bridge. Raising the crest of the present dam would render necessary expensive changes in the structures and machinery now in place for utilizing the water power.

With these facts in mind, I have prepared a project for placing in the dam near the south end a lock having the same dimensions as those in the canal, and excavating below it a channel of the same dimensions as the canal, except that it provides for a depth of 5 feet below the crest of the present dam. This depth is as great as the present pool affords except for limited areas. It is proposed to protect the excavated channel by a stone dike to be built of material excavated from the channel. The Sterling Hydraulic Company place flashboards on the crest of their dam during low water, so that the depth of 5 feet herein estimated for would be increased either by the depth of flow over the crest or by the flashboards placed on it.

After this project had been outlined and an estimate of cost made, I wrote to the citizens' committee having this matter in charge, asking if this project met with their approval. To this the committee replied that they had presented the matter to the parties interested, and that the project as outlined was considered entirely satisfactory. Copies of the correspondence are herewith.[1]

The estimated cost of the project is as follows:

15,272 cubic yards rock excavation, at $1.75 per cubic yard	$26,726
2,925 cubic yards concrete, at $8 per cubic yard	23,400
Lock gates	3,000
Pumping and draining	1,000
Engineering and contingencies, 10 per cent	5,412
Total estimated cost	59,538

This estimate has been prepared on the supposition that this work would be done in connection with the work on the feeder, using the same plant and organization. If the work was to be undertaken separately after the work of the feeder was completed, then the cost would be very considerably increased.

No item has been included in this estimate for protective works above the lock, as the same works for protecting the entrance to the feeder can be made to protect the lock in the dam. Neither has any item been included for raising the wagon bridge, as it is believed that, on account of its proximity to the dam, steamers will not find it necessary to pass under it.

At the time the land for the abutments for the dam was condemned, the question arose as to whether or not Rock River was a navigable stream. After hearing the evidence in the case, the jury returned a verdict that Rock River up as far as Dixon was a navigable waterway of the United States. It would seem inconsistent, then, for the United States to build a dam across the stream without making provision for navigation of the river. It is believed that the improvement as outlined above is worthy of being undertaken by the United States.

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[1] Not printed.

Accompanying this report is a map showing that portion of Rock River under discussion and the location of the proposed lock and dam.

Very respectfully, your obedient servant,

L. L. WHEELER,
Assistant Engineer.

Maj. J. H. WILLARD,
Corps of Engineers, U. S. A.

STATEMENT BY THE CITIZENS' COMMITTEE OF STERLING, ILL., GIVING TOTAL TONNAGE OF FREIGHT RECEIVED AND SHIPPED BY THE MANUFACTURERS AND COAL AND LUMBER DEALERS OF STERLING AND ROCKFALLS.

STERLING, ILL., *July 21, 1900.*

DEAR SIR: With other information submitted by this committee referring to the construction of a lock in the dam of the Hennepin Canal feeder, we gave the total tonnage of freight received and shipped by the manufacturers and coal and lumber dealers of Sterling and Rockfalls. We now beg to hand you an itemized memorandum of this tonnage.

In regard to the matter of raising the dam of the Sterling Hydraulic Company, this committee is not in a position to make a statement, as such action has not been supposed to be necessary, and little or no consideration has been given to the matter.

	Tons.
Sterling:	
Dillon Griswold Wire Company	110,000
Crescent Manufacturing Company	1,500
William Franke	2,000
Isaac Brimmer	800
E. Bauder	400
Charter Gas Engine Company	950
Charles Presbrey & Co	300
Empire Manufacturing Company	350
Grain	21,600
Hard and soft coal	34,000
Lumber	18,500
Sterling Gas and Electric Light Company	1,500
Rock Falls Manufacturing Company	1,260
Sterling Hearse Company	2,310
	195,470
Rockfalls:	
Keystone Manufacturing Company	11,660
Sterling Manufacturing Company	7,000
Rock Falls Paper Mill	26,000
Eureka Manufacturing Company	1,600
Dillon Milling Company	6,525
N. W. Barb Wire Company	18,100
Lawrence Brothers	8,000
Cobb & Drew	4,000
Coe & Van Sant	5,000
Smith & Grater	500
Electric Light Company	1,095
Peter Smith	150
Total	89,630

Very respectfully,

MOSES DILLON.
JOHN W. PLATT.
JAMES S. GREENOUGH.

Maj. J. H. WILLARD.

APPENDIX N N.

IMPROVEMENT OF MICHIGAN CITY HARBOR, INDIANA, AND OF RIVERS AND HARBORS ON THE EASTERN SHORE OF LAKE MICHIGAN.

REPORT FOR FISCAL YEAR ENDING JUNE 30, 1901, WITH OTHER DOCUMENTS RELATING TO THE WORKS. OFFICERS IN CHARGE, CAPT. CHESTER HARDING AND CAPT. CHARLES KELLER, CORPS OF ENGINEERS.

IMPROVEMENTS.

1. Michigan City Harbor, Indiana.
2. St. Joseph Harbor, Michigan.
3. St. Joseph River, Michigan.
4. South Haven Harbor, Michigan.
5. Saugatuck Harbor, Michigan.
6. Kalamazoo River, Michigan.
7. Holland (Black Lake) Harbor, Michigan.
8. Grand Haven Harbor, Michigan.
9. Grand River, Michigan.
10. Muskegon Harbor, Michigan.
11. White Lake Harbor, Michigan.
12. Pentwater Harbor, Michigan.
13. Ludington Harbor, Michigan.
14. Manistee Harbor, Michigan.
15. Harbor of refuge at Portage Lake, Manistee County, Michigan.
16. Frankfort Harbor, Michigan.
17. Charlevoix Harbor, Michigan.
18. Petoskey Harbor, Michigan.

EXAMINATION.

19. Muskegon Harbor, Michigan.

United States Engineer Office,
Grand Rapids, Mich., July 15, 1901.

General: I have the honor to submit herewith the annual reports relative to the works of river and harbor improvement in my charge for the fiscal year ending June 30, 1901.

* * * * * * *

Attention is invited to the fact that the depths in the various harbors are referred to the stage existing when the last soundings were made. As this stage is often a foot or more above the lowest stage of the season, the depths, as usually given, are apt to be dangerously misleading unless the matter is clearly understood by those interested in navigation.

Very respectfully, your obedient servant,

Charles Keller,
Captain, Corps of Engineers.

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. A.

N N I.

IMPROVEMENT OF MICHIGAN CITY HARBOR, INDIANA.

This improvement, begun in 1836, has provided an "inner harbor" for local commerce, and partly completed an "outer harbor" designed to facilitate entrance into the former and to serve as a harbor of refuge.

INNER HARBOR.

An account of operations in this harbor to June 30, 1900, is given on page 3874 of the report of the Chief of Engineers for 1900.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1901.

Between May 17 and June 11, 1901, 24,862 cubic yards were dredged under formal contract with Samuel O. Dixon, of Milwaukee, Wis. This dredging was for the purpose of reestablishing the required depth at the end of the piers, and rendering straighter and wider the crooked channel inside.

As a result there now exists a channel 18 feet deep and 100 feet wide through the shoal at the harbor entrance. Between the piers the channel is 15 feet deep and of navigable width. From the end of the piers to the Michigan Central Railroad bridge the depth is 14 feet, thence to the first bend above the Sixth Street bridge the depth is 13 feet, and from this last point to the lower end of the upper turning basin the depth is 12 feet.

The west pier between stations 2 + 28 and 6 + 14.3 has been repaired by the owner of the abutting property by driving a row of sheet piles along the front wall and refilling behind them.

CONDITION OF WORKS JUNE 30, 1901.

No change except decay due to natural causes has taken place in the works, and they remain, with the exception of the above-noted repairs, as stated upon page 3874 of the report of the Chief of Engineers for 1900.

WORK PROPOSED FOR NEXT FISCAL YEAR.

Nothing proposed owing to lack of funds.

ESTIMATE OF FUNDS FOR YEAR ENDING JUNE 30, 1903.

The estimate for year ending June 30, 1902, is repeated, with the extension of the repairs for the west pier from station 7 + 85, as then stated, to station 6 + 14, an addition of 171 feet. This portion of the west pier is in extremely poor condition and has caused rapid deterioration of the channel in its vicinity.

Estimate.

For maintenance:	
Sheet piling and building new superstructure for outer 1,544 feet of west pier, at $25	$38,600
Same for outer 735 feet of old east pier	18,375
Dredging	5,000
	61,975
Contingencies	6,225
Total	68,200

Amount appropriated and expended from 1836 to 1869, inclusive	$287,388.02
Original estimated cost of project for inner harbor, 1870, revised in 1892	131,375.00
Whole amount appropriated, 1870 to June 30, 1901	151,875.00
Whole amount expended, 1870 to June 30, 1901	150,468.28
Total expenditure from 1836 to June 30, 1901	437,852.05
Amount carried to surplus fund	5.15

Money statement.

July 1, 1900, balance unexpended	$3,543.45
June 30, 1901, amount expended during fiscal year	2,136.73
July 1, 1901, balance unexpended	1,406.72
July 1, 1901, outstanding liabilities	36.67
July 1, 1901, balance available	1,370.05
July 1, 1901, amount covered by uncompleted contracts	198.90
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement, in addition to the balance unexpended July 1, 1901	68,200.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

OUTER HARBOR.

The record of this improvement is brought to the beginning of the year in the Report of the Chief of Engineers for 1900, page 3875.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1901.

The property stored at this harbor was cared for by the watchman who is employed for this purpose, and who also maintains the pier lights. The Light-House Establishment has thus far made no provision for lighting the harbor structures.

Work under the contract with Stebbings & Wenzell for the extension of the east breakwater pier and the construction of a new detached breakwater has been continued. Progress has been exceedingly unsatisfactory, due to lack of requisite ability and experience on the part of the contractors. At the close of the year measures were being taken to secure better results. At present the following work has been accomplished: The dredging at the site of four cribs in the east breakwater pier has been finished, piles driven in the foundation of three of these cribs and partly driven in the case of the fourth, and 716.19 cords of stone placed in the foundation of the new detached breakwater. The contract has been extended to December 1, 1901.

For details of operations see the appended extract from the report of Assistant Engineer F. W. Lehnartz:

Contractors Stebbings & Wenzell continued operations under their contract for extending the breakwater pier 600 feet and for the construction of a new detached breakwater 1,400 feet long. During the season of 1900, the site for cribs 1, 2, 3, and 4 of the breakwater pier extension was dredged to the required depth, the foundation piles for cribs 1 to 3 and four of those for crib 4 were driven, and the construction of crib No. 1, twenty-two courses high, and of twelve courses of crib No. 2, and three courses of crib No. 3 was completed. Crib No. 1, which had been built under the lea of the old exterior breakwater and was moored to it, had its bottom timbers badly chafed during the storm of September 11 by surging against the stone riprap, and after much trouble was turned over on October 14 for repairs. Two days later the crib was torn from its moorings during a storm and drifted into the entrance channel, where it grounded opposite west pier station 17+50. While in this situation the bottom of the crib was repaired and endeavors were then made to release the crib, which were not successful until November 3. It was then towed back to its original place under shelter of the exterior breakwater, with a view of again turning it over and making such repairs as might be needed to the top courses. However, a new storm arose on November 8, during which the crib was again torn loose and forced on the beach close to the west pier, where it remained during the winter. The work done on the new detached breakwater consisted in placing 523.14 cords stone in the foundation between stations 0 and 4+40, and between stations 13 and 14+10. Operations were suspended for the winter on December 11. When they were resumed on April 29, it was found that crib No. 1 was so deeply embedded in the shore sands, and was so badly shaken up, that the contractor abandoned it and started the construction of a new crib in its place. At the end of the fiscal year, this construction had advanced to the fifteenth course, and that of crib No. 3 had been completed to the eighth course. An examination of the foundation piles of crib No. 1, resulted in finding 11 piles driven outside of the established limits and several others sawed off too low. Since then the 11 piles out of line have been replaced by new ones, and the low piles will be brought to the required level by fastening iron caps of a special design and of the required thickness on top. In addition, 273.05 cords stone were placed in the foundation of the detached breakwater, making a total quantity of 716.19 cords placed in this work during the fiscal year.

During the month of November some repairs by day labor and with old material were made to the decking of the exterior breakwater.

CONDITION OF WORKS ON JUNE 30, 1901.

This is as stated in the Report of the Chief of Engineers for 1899, page 2898

WORK PROPOSED FOR NEXT FISCAL YEAR.

Operations under the Stebbings & Wenzell contract will be continued.

ESTIMATE OF FUNDS FOR FISCAL YEAR ENDING JUNE 30, 1903.

Under the head of "Maintenance" an estimate is submitted as follows: For closing the entrance to the outer basin, 460 feet of pile work, at $30, and contingencies, $15,000. The basis of the estimate is fully explained in the annual report for 1899, page 2898.

The harbor is in the collection district of Chicago, Ill., which city is the nearest port of entry.

Original estimated cost of project for outer harbor, 1870	$324,421.40
Increased by cost of repairs and maintenance to 1882	90,067.10
Project for outer breakwater, including dredging of outer basin, 1882	587,000.00
Estimated remaining cost of amended project, 1899	282,150.00
Whole amount appropriated and allotted, 1870 to June 30, 1901	1,036,875.00
Whole amount expended, 1870 to June 30, 1901	767,617.43

Money statement.

July 1, 1900, balance unexpended	$278,841.16
June 30, 1901, amount expended during fiscal year	9,583.59
July 1, 1901, balance unexpended	269,257.57
July 1, 1901, outstanding liabilities	236.25
July 1, 1901, balance available	269,021.32
July 1, 1901, amount covered by uncompleted contracts	252,356.80
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement, in addition to the balance unexpended July 1, 1901	15,000.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

Appropriations for improving harbor at Michigan City, Ind.

Date.	Outer harbor.	Inner harbor.	Total.
July 4, 1836			$20,000.00
March 3, 1837			30,000.00
July 7, 1838			60,733.59
June 11, 1844			25,000.00
August 30, 1852[a]			20,000.00
March 2, 1855 (claim of J. R. Bowes)			470.33
June 23, 1866			75,000.00
July 25, 1868 (allotment)			25,000.00
April 10, 1869 (allotment)			31,185.00
July 11, 1870	$25,000.00		25,000.00
March 3, 1871	15,000.00		15,000.00
June 10, 1872	50,000.00		50,000.00
March 3, 1873	50,000.00		50,000.00
June 23, 1874	50,000.00		50,000.00
March 3, 1875	50,000.00		50,000.00
August 14, 1876	35,000.00		35,000.00
June 18, 1878	50,000.00	$25,000.00	75,000.00
1878 (allotment)	2,500.00		2,500.00
March 3, 1879	40,000.00		40,000.00
June 14, 1880	40,000.00	15,000.00	55,000.00
March 3, 1881	20,000.00	25,000.00	45,000.00
August 2, 1882	60,000.00	20,000.00	80,000.00
July 5, 1884	40,000.00	10,000.00	50,000.00
August 5, 1886	54,375.00	1,875.00	56,250.00
August 11, 1888	90,000.00	5,000.00	95,000.00
September 19, 1890	50,000.00	7,500.00	57,500.00
July 13, 1892	30,000.00	15,000.00	45,000.00
August 18, 1894	20,000.00	10,000.00	30,000.00
June 3, 1896	70,000.00	10,000.00	80,000.00
March 3, 1899		7,500.00	7,500.00
June 6, 1900	195,000.00		195,000.00
Total	1,036,875.00	151,875.00	1,476,138.92

[a] Amount carried to surplus fund, $5.15.

ABSTRACT OF CONTRACTS IN FORCE FOR IMPROVING HARBOR AT MICHIGAN CITY, IND.

Inner harbor—Dredging.

Contractor: Green's Dredging Company.
Date of contract: March 24, 1900.
Date of approval: April 12, 1900.
Date of beginning: April 29, 1900.
Date of expiration: September 30, 1900.
Rates: 16½ cents per cubic yard for dredging and $3 per mile for transfer of plant.

Contractor: Samuel O. Dixon.
Date of contract: May 1, 1901.
Date of approval: May 11, 1901.
Date of beginning: May 30, 1901.
Date of expiration: December 1, 1901.
Rate: 8 cents per cubic yard.

Outer harbor—Construction of breakwaters.

Contractor: Stebbings & Wenzell.
Date of contract: February 3, 1900.
Date of approval: February 21, 1900.
Date of beginning: May 1, 1900.
Date of expiration: June 30, 1901; extended to December 1, 1901.

Rates: Dredging at $1 per cubic yard; foundation piles at 30 cents per linear foot; white oak timber at $50 per M feet B. M.; white pine timber at $30.80 per M feet B. M.; hemlock timber at $24 per M feet B. M.; white pine decking at $25 per M feet B. M.; driftbolts, screw bolts, and spikes at 4 cents per pound; stone at $7.50 per cord.

COMMERCIAL STATISTICS FOR MICHIGAN CITY HARBOR, INDIANA, CALENDAR YEAR ENDING DECEMBER 31, 1900

Entrances and clearances.

Calendar year.	Number.	Tonnage.	Calendar year.	Number.	Tonnage.
1888	1,153	208,617	1895	343	91,016
1889	795	169,193	1896	437	106,543
1890	921	172,817	1897	492	118,137
1891	837	168,654	1898	478	127,237
1892	1,391	443,055	1899	601	144,880
1893	1,577	589,863	1900	412	102,323
1894	389	119,929			

Character of vessels.

	Number.	Tonnage.
Steam	308	77,816
Sail	104	24,507
Total	412	102,323

Maximum draft, 13 feet, in inner harbor.

Receipts[1] and shipments by vessel, 1900.

[Compiled from statement furnished by Mr. Charles J. Robb, surveyor of customs at Michigan City, Ind.]

Articles shipped.	Tons.	Articles shipped.	Tons.
Lumber	90,965	Railroad ties	16,451
Cedar posts	10	Salt	7,812
Shingles	2,009	Total	120,135
Laths	2,831		
Potatoes	57		

NOTE.—No record is kept of traffic between Michigan City and Chicago.

[1] Not given.

N N 2.

IMPROVEMENT OF ST. JOSEPH HARBOR, MICHIGAN.

The report of the Chief of Engineers for 1900, page 3879, carries the history of this work to July 1, 1900.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1901.

The contract with John M. Allmendinger, of St. Joseph, Mich., for the repair of 819 feet of the south pier has been completed. This contract was to have been completed November 1, 1899, but was extended to November 1, 1900.

Operations have been continued upon the contract with the Lydon & Drews Company, of Chicago, for pier extension in progress at the beginning of the fiscal year. Seven cribs intended for the south pier have been completed. Crib No. 8 for this pier was finished as far as the sixteenth course, and crib No. 1 for the north pier was begun. Crib 1, south pier, is partly filled in place upon its foundation. This contract has been extended to December 1, 1901.

Dredging under contract with Samuel O. Dixon, of Milwaukee, Wis., was begun upon June 14, and during the remainder of the month 26,767 cubic yards were dredged.

A detailed description of the above operations is contained in the appended extract from the report of Assistant Engineer F. W. Lehnartz:

Dredging operations under the contract with Samuel O. Dixon were commenced June 14, and at the close of the fiscal year three adjacent cuts had been made through the shoal at the entrance for a distance of about 1,000 feet out from the end of the south pier, with a fourth cut 510 feet long, commencing inside and extending to north pier, station 0; one cut from the outer end of the south pier to Graham's dock, station 1, and a cut 200 feet long at the upper end of the shoal reach above the railroad bridge. All these cuts are 30 feet wide and 20 feet deep below zero of gauge. The dredged material was 26,767 cubic yards.

The repairs of the old section of the south pier in progress at the beginning of the fiscal year under contract of John M. Allmendinger, as described in the annual report for 1899, page 2901, were finally completed at the end of October. The driving of sheet piles was greatly retarded by the stone and other obstructions in the bottom and by the effect of the storm of September 11, which destroyed 82 linear feet of sheet piling already in place, together with the guide and binding timbers, wale, tie-rods, and a portion of the first course of the rear wall of the superstructure. Without this damage the contract would probably have been completed a month earlier. As heretofore described, the length of the pier repaired is 819 feet, and the repairs consisted in cutting the old work down to the level of zero of gauge, protecting the channel wall of the substructure by triple sheet piles made of 3 by 12 inch by 26-foot white-pine planks, and by round oak piles driven 4 feet between centers and 34 feet long in the work, connecting the whole with the old work by means of guide and binding timbers, front wale, screw bolts, and tie-rods, and building a new superstructure 6 feet high on top. A plank walk 4 feet wide was laid on the new work.

Under the contract with the Lydon & Drews Company the following work has been done: The construction of seven cribs, each 100 by 24 by 18½ feet, for the south pier extension has been completed; crib No. 8, of the same dimensions and for the same pier, has had 16 courses completed, and the first two courses of crib No. 1 for the north pier extension have been built. The site for cribs 1 and 2 in the south pier has been dredged to the required depth, the foundation piles for these two cribs and two piles for crib 3 have been driven, and crib 1 was sunk in its place June 24, although it is as yet only partially filled with stone. Operations under this contract were suspended between November 17 and May 8.

CONDITION OF WORKS ON JUNE 30, 1901.

At the beginning of the season of 1901 the following available depths existed in this harbor, as shown by the soundings made May 3–7, at a stage of −1.1 feet: Seventeen feet on the crossing of the outer bar, 14.5 feet on the shoal extending across the channel between the ends of the two piers, 14 feet from the inner end of the piers to the railroad bridge, 11 to 12 feet thence to the mouth of the St. Joseph River, and 13.5 feet in the Benton Harbor canal.

The north pier and revetment, comprising 1,182 feet of crib work, 670 feet of pile work in the main pier, and 165 feet of pile work in the wing connecting the pier with the light-house dock, have a total length of 2,017 feet and project 1,010 feet beyond the shore line. The pile work in the main pier and 379 feet of the crib work are sheet piled and in good condition. The crib work between stations 0 and 4 + 55 was built between 1875 and 1881 and is in bad condition. The remaining crib work is in good condition except for a break in the channel wall for a length of 11 feet, caused by a collision of the steamer *City of Milwaukee* of the Graham & Morton Line on June 9, 1900, and for a considerable subsidence of the filling in the side pockets.

The south pier consists of 819 feet of old pile and crib work, rebuilt with sheet piles and new superstructure during the past two years, and of 100 feet of new crib work as yet without superstructure. The first-mentioned part of the pier is in need of additional filling. The pier projects 640 feet beyond the shore line.

The contract now in force with the Lydon & Drews Company provides for a further addition of 1,700 feet to the south pier and of 1,000 feet to the north pier.

WORK PROPOSED FOR NEXT FISCAL YEAR.

The dredging operations under the contract with Samuel O. Dixon, for deepening the harbor to 18 feet and the Benton Harbor Canal to 15 feet, will be completed.

The operations under the Lydon & Drews Company contract for the extension of the piers will be continued. The break in the front wall of the north pier caused by the steamer *City of Milwaukee* will be repaired.

ESTIMATE OF FUNDS FOR FISCAL YEAR ENDING JUNE 30, 1903.

All funds necessary for the completion of the approved project have been appropriated.

The following is the estimate for maintenance:

Rebuilding above water 455 feet north pier	$7,500
Refilling piers	5,500
Dredging	11,000
Total	24,000

The harbor is in the collection district of Grand Haven, Mich., which city is the nearest port of entry.

Original estimated cost of work, as revised in 1897	$593,113.00
Estimated cost of modified project adopted in 1899	358,000.00
Whole amount expended to June 30, 1901	525,282.97

Money statement.

July 1, 1900, balance unexpended	$284,539.25
Amount appropriated by sundry civil act approved March 3, 1901	38,000.00
	322,539.25
June 30, 1901, amount expended during fiscal year	12,760.02
July 1, 1901, balance unexpended	309,779.23
July 1, 1901, outstanding liabilities	82.50
July 1, 1901, balance available	309,696.73
July 1, 1901, amount covered by uncompleted contracts	288,554.38
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement, in addition to the balance unexpended July 1, 1901 Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	24,000.00

Appropriations for improving St. Joseph Harbor and River, Michigan.

July 4, 1836		$20,000.00
March 3, 1837		15,000.00
July 7, 1838		51,113.00
March 3, 1843		25,000.00
June 11, 1844		20,000.00
August 30, 1852		10,000.00
June 28, 1864 (allotment)		15,000.00
June 23, 1866		6,000.00
March 2, 1867		23,000.00
Allotted from harbors on Northwestern Lakes, 1867	$7,500.00	
Transferred in 1870 to Grand Haven Harbor	500.00	
		7,000.00
July 11, 1870		15,000.00
March 3, 1871		10,000.00
June 10, 1872		3,000.00
June 23, 1874		2,000.00
March 3, 1875		35,000.00

August 14, 1876	$12,000.00
June 18, 1878	12,000.00
March 3, 1879	6,000.00
June 14, 1880	8,000.00
March 3, 1881	10,000.00
August 2, 1882	12,000.00
July 5, 1884	15,000.00
August 5, 1886	10,000.00
August 11, 1888	12,000.00
September 19, 1890	20,000.00
July 13, 1892	59,000.00
August 18, 1894	30,000.00
June 3, 1896	30,000.00
March 3, 1899	50,000.00
June 6, 1900	253,950.00
March 3, 1901	38,000.00
Total	835,063.00
Amount carried to surplus fund, 1856	.80
	835,062.20

ABSTRACT OF CONTRACTS IN FORCE IMPROVING HARBOR AT ST. JOSEPH, MICH.

Dredging.

Contractor: Green's Dredging Company.
Date of contract: March 24, 1900.
Date of approval: April 12, 1900.
Date of beginning: April 29, 1900.
Date of expiration: September 30, 1900.
Rates: 16½ cents per cubic yard for dredging and $3 per mile for transfer of plant.

Contractor: Samuel O. Dixon.
Date of contract: May 1, 1901.
Date of approval: May 11, 1901.
Date of beginning: May 30, 1901.
Date of expiration: December 1, 1901.
Rate: 8 cents per cubic yard.

Repair of pier.

Contractor: John M. Allmendinger.

Date of contract: June 3, 1899.

Date of approval: June 20, 1899.

Date of beginning: June 1, 1899.

Date of expiration: November 1, 1899; extended to July 1, 1900, September 1, 1900, and November 1, 1900.

Rates: Cutting down old work, at $1.25 per linear foot; placing and securing white-pine timber, furnished by Government, at $5 per M feet B. M.; placing and securing white-pine plank, furnished by Government, at $4 per M feet B. M.; white-oak round piles, at 27 cents per linear foot; white-oak timber, at $32 per M feet B. M.; white-pine timber, at $24 per M feet B. M.; white-pine plank sheet piles, at $28 per M feet B. M.; white-pine plank decking, at $20 per M feet B. M.; driftbolts, at 2½ cents per pound; screw bolts, carriage bolts, and tie-rods, at 3½ cents per pound; spikes, at 3 cents per pound; stone, at $6.50 per cord.

Pier extension.

Contractor: The Lydon & Drews Company.

Date of contract: January 12, 1900.

Date of approval: February 5, 1900.

Date of beginning: May 1, 1900.

Date of expiration: June 30, 1901; extended to December 1, 1901.

Rates: Dredging, at 25 cents per cubic yard; foundation piles, at 25 cents per linear foot; white-oak guard piles, at 25 cents per linear foot; white-oak timber, at $50 per M feet B. M.; white-pine timber, at $31.20 per M feet B. M.; hemlock timber, at $24.50 per M feet B. M.; white-pine plank decking, at $27.60 per M feet B. M.; driftbolts, screw bolts, and spikes, at 4 cents per pound; stone, at $6 per cord.

COMMERCIAL STATISTICS FOR ST. JOSEPH HARBOR, MICHIGAN, CALENDAR YEAR ENDING DECEMBER 31, 1900.

Entrances and clearances.

Calendar year.	Vessels entered.		Vessels cleared.	
	Number.	Tonnage.	Number.	Tonnage.
1890	948	131,607	946	181,895
1891	742	215,334	743	215,591
1892	1,726	707;285	1,727	707,785
1893	1,576	1,125,063	1,575	1,125,938
1894	1,100	900,000	1,100	900,000
1895	779	327,384	727	327,837
1896	835	439,031	833	435,033
1897	842	385,915	849	348,040
1898	948	1,216,567	943	1,114,560
1899	853	446,178	851	430,411
1900	940	453,543	934	442,419

Character of vessels.

	Number.	Tonnage.
Steam	1,763	889,249
Sail	111	6,713
Total	1,874	895,962

Maximum draft, 17 feet to railroad bridge, 11.5 feet throughout.

Receipts and shipments by vessel, 1900.

[Compiled from statements furnished by W. S. Howard, deputy collector of customs at St. Joseph, Mich., and S. G. Antisdale, deputy collector of customs at Benton Harbor, Mich.]

Articles received.	Tons.	Articles shipped.	Tons.
Iron	120	Fruit, miscellaneous	59,218
Cement	2,061	Flour	85
Cedar posts	746	Potatoes	74
Laths	266	Cider	40
Shingles	64	Vinegar	35
Lumber	2,030	Merchandise, miscellaneous	31,575
Hides	95		
Paper	100		
Hay and feed	6,314		
Flour	2,764		
Salt	5,772		
Merchandise, miscellaneous	42,882		
Total	63,214	Total	91,027

The Benton Transit Company, doing a general shipping business, with terminal at Chicago, was established during the year

N N 3.

IMPROVEMENT OF ST. JOSEPH RIVER, MICHIGAN.

The purpose of this improvement is to maintain a low-water channel 3 feet deep from Berrien Springs, Mich., to the mouth of the river in St. Joseph Harbor. Work was begun in 1889 and has been continued when funds have been available. The improvement consists in removing snags, closing secondary channels, and producing scour over shoals by the construction of wing dams of brush, logs, and stone.

Owing to lack of funds, no work was done during the year or is now proposed for the next fiscal year.

ESTIMATE FOR FISCAL YEAR ENDING JUNE 30, 1903.

The cost of improving the stream was estimated in 1880 at $11,300, but that estimate related to cost of original construction only. Improvements of this character require more or less work each year, and the cost of completion is wholly a matter of how long the work is to be kept up and the average annual cost of doing it. In the present instance the mean annual expenditure has been $500, and experience shows that it is too little to accomplish what the approved project requires, but $750 would probably suffice.

Money statement.

July 1, 1900, balance unexpended	$9.89
June 30, 1901, amount expended during fiscal year	.80
July 1, 1901, balance unexpended	9.09
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement, in addition to the balance unexpended July 1, 1901	750.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

Appropriations for improving St. Joseph River, Michigan.

August 11, 1888	$2,500
September 19, 1890	1,000
July 13, 1892 (allotment)	1,000
August 18, 1894	500
June 3, 1896	500
Total	5,500

COMMERCIAL STATISTICS FOR ST. JOSEPH RIVER, MICHIGAN, CALENDAR YEAR ENDING DECEMBER 31, 1900.

[Compiled from statement furnished by Mr. E. A. Graham, St. Joseph, Mich.]

The steamers *May Graham* and *Tourist* carried 25,000 passengers and 2,419 tons of miscellaneous freight between St. Joseph and Berrien Springs. The boats draw 34 and 30 inches, respectively.

N N 4.

IMPROVEMENT OF HARBOR AT SOUTH HAVEN, MICHIGAN.

The history of this work is carried to the beginning of the year in the Report of the Chief of Engineers for 1900, page 3884.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1901.

At the beginning of the year operations upon repairs to and extension of north pier were in progress under formal contract with Smith & Nelson, of Muskegon, Mich. Owing to the wrecking of a stone barge, this contract could not be completed before the expiration of the contract limitation (December 1), and by authority of the Chief of Engineers the time of completion was extended to July 1, 1901. The contract was actually completed upon June 3, 1901, and has resulted in the extension of the north pier by two cribs, each 100 by 24 by 16½ feet, capped with 6-foot superstructure, and in the thorough repair and strengthening of 254 feet of this pier immediately adjoining the above new work, at a total cost of $25,275.77.

The details of the work under this contract are contained in the following extract from the report of the Assistant Engineer F. W. Lehnartz:

> The pier extension involved the placing of two cribs, each 100 feet long, 24 feet wide, and 16½ feet deep, on a pile foundation surmounted by a continuous superstructure 6 feet high. Previous to the pile driving the site of the crib had to be dredged to a depth of 18 feet below zero. The first crib was sunk in place on August 4, and the second crib on October 4. The driving of the oak guard piles, the placing of the three horizontal guard timbers above water between the outer end horns and of the snubbing posts, the timber work of the superstructure except the last 23 feet of the top course were completed before the close of the working season. The adjacent part of the old pier, 254 feet in length, and consisting of cribs 32 feet wide was cut down to the level of zero of guage. The front wall was strengthened with a row of oak piles, 4 feet between centers from stations 13+39 to 15+79 and 2 feet between centers from stations 15+79 to 15+91, driven in close contact with the old work and secured by means of an oak front wale and screw bolts and tie-rods. The new superstructure, 6 feet high, rests with the front wall on the new front piles, and with the rear wall on one of the interior walls of the substructure, and is 22 to 23

feet wide. With reference to the part of the substructure projecting to the rear of the new superstructure, it was proposed to repair the top of the rear wall with a new 12 by 12 inch timber, to fill the work with stone, and to deck it from one end to the other with 6 by 12 inch timber. This plan was partly frustrated by the storm of September 11, which tore out the old rear wall between stations 13+40 and 13+90 to a depth of 2 to 4 feet below water and loosened the remainder of the wall farther down, as also the portion of the wall between stations 13+90 and 14+34, and between stations 14+74 and 15+14. In consequence of this damage it was impracticable to deck the projecting work between stations 13+40 and 13+90, and as the remainder of the rear wall was in danger of being torn out by the sea during some future storm, it became necessary to strengthen it, which was done by driving oak piles along the lake face and fastenening them by means of a wale and tie-rods to the interior timbers of the pier. By this time it had become very late in the season, and as the contractors lost their stone scows while passing through Sturgeon Bay Canal, they were unable to complete the work before winter and suspended operations on December 11, after having put a temporary deck on the new superstructure for its protection. Operations were resumed May 14, the temporary deck on the superstructure was removed, the cross timbers in the low projecting work of the old pier were leveled up, the entire structure from station 13+40 to the outer end of the new crib work was filled with stone to the top, and the superstructure was decked with 3 by 12 inch plank, and the low work in the rear between stations 13+98 and 15+93.5 with 6 by 12 inch timbers. The date of completion of the contract was June 3.

CONDITION OF WORKS, JUNE 30, 1901.

The north pier consists of 987 feet of pile work and 806 feet of crib work, has a total length of 1,793 feet, and projects 910 feet beyond the shore line. It is in fair condition, except that the filling in 524 feet of the pile work has settled badly and that the top timbers of the remainder of the pile work are somewhat rotten.

The south pier, beginning at the inner end, consists of 997 feet of pile work, 556 feet of crib work, 179 feet of sheet-pile pier, and 50 feet of crib work; has a total length of 1,782 feet, and projects 710 feet beyond the shore line. The pier is in good condition, except that 143 feet of the pile work needs additional filling.

The channel between the piers has never been dredged to its full capacity, and this should be done. The channel in the river to the highway bridge is narrow and needs widening and deepening.

WORK PROPOSED FOR NEXT FISCAL YEAR.

An allotment of $1,000 from the appropriation for emergencies in river and harbor works, act of June 6, 1900, together with available balance of the appropriation for this harbor, will be expended in the restoration of the depth and width of the main channel by dredging under formal contract with Samuel O. Dixon, of Milwaukee, Wis., dated May 1, 1901.

ESTIMATE OF FUNDS FOR FISCAL YEAR ENDING JUNE 30, 1903.

So far as new construction goes, the existing project is completed. Dredging will, however, continue to be a large annual expense until the piers are extended at least as far as the 14-foot contour of Lake Michigan. The following estimate for maintenance is submitted:

Refilling 667 linear feet of pile piers and minor repairs	$2,000
Dredging	10,000
	12,000
Contingencies	1,200
Total	13,200

The harbor is in the Grand Haven, Mich., collection district, which city is the nearest port of entry.

Original estimated cost of the work, 1866, amended in 1869, 1872, 1892, and 1898	$317,000.00
Whole amount expended to June 30, 1901	295,863.30

Money statement.

July 1, 1900, balance unexpended	$32,021.80
March 21, 1901, amount allotted from appropriation for emergencies in river and harbor works, act of June 6, 1900	1,000.00
	33,021.80
June 30, 1901, amount expended during fiscal year	30,885.10
July 1, 1901, balance unexpended	2,136.70
July 1, 1901, amount covered by uncompleted contracts	2,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement, in addition to the balance unexpended July 1, 1901	13,200.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

Appropriations for improving harbor at South Haven, Mich.

March 2, 1867	$43,000	August 2, 1882	$10,000
July 11, 1870	10,000	July 5, 1884	7,500
March 3, 1871	15,000	August 5, 1886	5,000
June 10, 1872	12,000	August 11, 1888	10,000
March 3, 1873	20,000	September 19, 1890	15,000
June 23, 1874	10,000	July 13, 1892	10,000
March 3, 1875	10,000	August 18, 1894	20,000
August 14, 1876	10,000	June 3, 1896	15,000
June 18, 1878	12,000	March 3, 1899	45,000
March 3, 1879	7,500	June 6, 1900 (allotment)	1,000
June 14, 1880	5,000		
March 3, 1881	5,000	Total	298,000

ABSTRACT OF CONTRACTS IN FORCE FOR IMPROVING HARBOR AT SOUTH HAVEN, MICH.

Dredging.

Contractor: Green's Dredging Company.
Date of contract: March 24, 1900.
Date of approval: April 12, 1900.
Date of beginning: April 29, 1900.
Date of expiration: September 30, 1900.
Rates: 16½ cents per cubic yard for dredging, and $3 per mile for transfer of plant.

Contractor: Samuel O. Dixon.
Date of contract: May 1, 1901.
Date of approval: May 11, 1901.
Date of beginning: May 30, 1901.
Date of expiration: October 15, 1901.
Rate: 13 cents per cubic yard.

Extension and repair of pier.

Contractors: Smith & Nelson.
Date of contract: February 13, 1900.
Date of approval: March 3, 1900.
Date of beginning: May 1, 1900.
Date of expiration: December 1, 1900; extended to July 1, 1901.

Rates: Cutting down old work at $2 per linear foot; dredging, at 40 cents per cubic yard; foundation piles, at 50 cents per linear foot; white-oak round piles, at 50 cents per linear foot; white-oak timber, at $50 per M feet B. M.; white-pine timber, at $29 per M feet B. M.; hemlock timber, at $23 per M feet B. M.; white-pine plank, at $26 per M feet B. M.; drift bolts, screw bolts, tie rods, and spikes, at 4 cents per pound; stone, at $7.75 per cord.

COMMERCIAL STATISTICS FOR SOUTH HAVEN HARBOR, MICHIGAN, CALENDAR YEAR ENDING DECEMBER 31, 1900.

Entrances and clearances.

Calendar year.	Number.	Tonnage.	Calendar year.	Number.	Tonnage.
1889 (estimated)	1,080		1895	3,222	238,060
1890	2,246	128,880	1896	1,218	343,016
1891	2,994	201,380	1897	1,256	351,000
1892	3,060	212,160	1898	771	322,620
1893	3,822	251,730	1899	682	276,117
1894	3,246	228,246	1900	1,231	407,289

Character of vessels.

	Number.	Tonnage.
Steam	997	398,125
Sail	234	9,164
Total	1,231	407,289

Maximum draft, 10.4 feet.

Receipts and shipments by vessel, 1900.

[Compiled from statement furnished by the deputy collector of customs at South Haven, Mich.]

Articles received.	Tons.	Articles shipped.	Tons.
Stone	3,300	Live stock	82
Lumber	6,510	Fruit, miscellaneous	20,623
Live stock	95	Merchandise, miscellaneous	5,254
Grain	111		
Merchandise, miscellaneous	7,233	Total	25,959
Total	17,249		

During the season of 1900 the H. W. Williams Transportation Company carried 100,000 passengers between South Haven and Chicago.

During the past spring the Dunkley Line of steamers, doing a passenger and freight business between South Haven and Chicago, was established.

N N 5.

IMPROVEMENT OF SAUGATUCK HARBOR, MICHIGAN.

The account of this improvement is brought to the beginning of the fiscal year in the Report of the Chief of Engineers for 1900, page 3887.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1901.

These have been restricted to the customary dredging. Under contract with Green's Dredging Company, the channel, upon which work had been done near the close of the last fiscal year, was, between July 10 and August 2, further extended by a cut 12 feet deep, 50 feet wide, and 170 feet long through the shoal in front of the entrance, and a cut 25 feet wide and 11.6 feet deep through the inner shoals for a distance of 3,200 linear feet. The total dredged was 13,867 cubic yards, and the harbor was thereby rendered navigable to the usual extent for the remainder of the season. When examined, April 29 to May 1, the shoal at the entrance showed a depth of but 2.3 feet, and inside the piers the depth varied from 5 to 7.8 feet. Under an allotment of $5,000 from the appropriation for emergencies in river and harbor works, act of June 6, 1900, dredging operations under contract with Samuel O. Dixon, of Milwaukee, Wis., were resumed upon June 10, and by the close of the year 22,549 cubic yards had been removed. A cut 50 feet wide and 12 feet deep at the prevailing stage had been made through the outer bar for a length of 900 feet outward from the end of the south pier, and a cut 25 feet wide and 10 feet deep at prevailing stage had been made inside for a length of 1,250 feet. Although the contract remained unfinished, at the close of the year the usual traffic was once more in progress.

CONDITION OF WORK ON JUNE 30, 1901.

This remains as described in the report of the Chief of Engineers for 1900, page 3888.

WORK PROPOSED FOR NEXT FISCAL YEAR.

Dredging under the contract with Samuel O. Dixon will be continued to the extent permitted by available funds.

ESTIMATE OF FUNDS FOR FISCAL YEAR ENDING JUNE 30, 1903.

As the adopted project for the improvement of Kalamazoo River involves the abandonment of the present mouth of the river, which constitutes the harbor of Saugatuck, no steps are proposed for the repairs of the existing harbor structures, and funds are asked for only for the purpose of temporarily maintaining the present outlet by dredging. Until funds become available for carrying out the Kalamazoo River project, the condition of affairs at Saugatuck harbor will continue to grow worse, and the amount necessary to expend annually for temporary relief by dredging will increase. The customary estimate for this purpose for several years past has been $10,000, but the conditions that have existed this season indicate that to give the commerce at this harbor a reasonably safe and free outlet during the seasons of 1902 and 1903 will require no less than $15,000.

The harbor is in the collection district of Grand Haven, Mich., which city is the nearest port of entry.

Original estimated cost of work, 1867, modified in 1869, 1870, 1875, and 1892	$175,699.46
Whole amount expended to June 30, 1901	176,826.90

Money statement.

July 1, 1900, balance unexpended		$567.69
Allotments from appropriation for emergencies in river and harbor works, act of June 6, 1900:		
July 2, 1900	$2,500.00	
March 21, 1901	5,000.00	
		7,500.00
		8,067.69
June 30, 1901, amount expended during fiscal year		2,955.59
July 1, 1901, balance unexpended		5,112.10
July 1, 1901, outstanding liabilities		103.00
July 1, 1901, balance available		5,009.10
July 1, 1901, amount covered by uncompleted contracts		5,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement, in addition to the balance unexpended July 1, 1901 Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		15,000.00

Appropriations for improving harbor at Saugatuck, Mich.

July 25, 1868 (allotment)	$23,900	March 3, 1881	$5,000
April 10, 1869 (allotment)	6,039	August 2, 1882	8,000
July 11, 1870	10,000	July 5, 1884	4,000
March 3, 1871	10,000	August 5, 1886	8,000
June 10, 1872	15,000	August 11, 1888	5,000
March 3, 1873	10,000	July 13, 1892	5,000
June 23, 1874	10,000	August 18, 1894	12,000
March 3, 1875	10,000	June 3, 1896	10,000
August 14, 1876	3,000	March 3, 1899	7,000
June 18, 1878	2,500	June 6, 1900 (allotments)	7,500
March 3, 1879	5,000		
June 14, 1880	5,000	Total	181,939

ABSTRACT OF CONTRACTS IN FORCE FOR IMPROVING HARBOR AT SAUGATUCK, MICH.

Dredging.

Contractor: Green's Dredging Company.
Date of contract: March 24, 1900.
Date of approval: April 12, 1900.
Date of beginning: April 29, 1900.
Date of expiration: September 30, 1900.
Rates: 16½ cents per cubic yard for dredging and $3 per mile for transfer of plant.

Contractor: Samuel O. Dixon.
Date of contract: May 1, 1901.
Date of approval: May 11, 1901.
Date of beginning: May 30, 1901.
Date of expiration: October 15, 1901.
Rate: 13 cents per cubic yard.

COMMERCIAL STATISTICS FOR SAUGATUCK HARBOR, MICHIGAN, FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1900.

Entrances and clearances.

Calendar year.	Number.	Tonnage.	Calendar year.	Number.	Tonnage.
1888	262	132,400	1895	1,256	134,948
1889	314	76,300	1896	848	153,190
1890	178	42,000	1897	586	70,360
1891	492	120,000	1898	1,329	128,325
1892	(a)	(a)	1899	1,190	88,236
1893	626	162,632	1900	1,859	120,946
1894	862	106,000			

a Not stated.

Character of vessels.

	Number.	Tonnage.
Steam	1,327	110,428
Sail	532	10,518
Total	1,859	120,946

Maximum draft, 5 feet.

Receipts and shipments by vessel, 1900.

[Compiled from statement furnished by Messrs. Griffin & Henry, of Saugatuck, Mich.]

Articles received.	Tons.	Articles shipped.	Tons.
Coal	3,000	Live stock	13
Lime and cement	130	Fish	18
Lumber	1,750	Potatoes	37
Cedar posts	20	Apples	277
Shingles	125	Peaches	5,185
Laths	30	Fruit, miscellaneous	1,243
Merchandise, miscellaneous	756	Farm products, miscellaneous	22
Total	5,811	Total	6,795

N N 6.

IMPROVEMENT OF KALAMAZOO RIVER, MICHIGAN.

The river and harbor act of June 3, 1896, provided the following in relation to this proposed improvement:

> Improving Kalamazoo River, Michigan, from Lake Michigan to Saugatuck, in accordance with the alternative project submitted January twenty-eighth, eighteen hundred and ninety-six, five thousand dollars.

The act of March 3, 1899, appropriated $10,000 for continuing the improvement.

The alternative project referred to is printed in the report of the Chief of Engineers for 1896, pages 2741 to 2743, the purpose being to establish a shorter and more easily maintained line of water communication from Saugatuck to Lake Michigan than that now afforded through Saugatuck Harbor. It provides for dredging the river from the town to a point 1¾ miles below it, and thence, making a new cut 12 feet deep, through to Lake Michigan.

The essential feature is the cut from river to lake and the construction of revetments and piers that are necessary for giving any degree of permanence. The appropriations thus far made are entirely inadequate for the work under the project, and nothing has been done or is now proposed, the funds being held in reserve until such time as the amount made available by Congress will justify the commencement of the work.

ESTIMATE OF FUNDS FOR FISCAL YEAR ENDING JUNE 30, 1903.

The present revised estimate of cost is $250,000. Before beginning work under the project it is essential to have funds available for completing the cut, for revetting its banks, and for extending the piers to a depth of 10 feet in Lake Michigan. For these purposes the sum of at least $200,000 would be required. The execution of this project is complicated by the fact that the old outlet must be maintained until the new is ready for use and that as soon as a cut is made through from Lake Michigan to the river the old outlet will deteriorate rapidly. An attempt to open the new cut before funds are available for giving a channel at least as good as that which can be maintained in the present outlet would result in a practical closing of the harbor. These conditions make this work one in which it is particularly desirable to have the completion of the project provided for before beginning work, and the continuing contract system would seem to be especially applicable to it.

The expediency of providing for this improvement at an early date may be inferred from the report on Saugatuck Harbor, above. The necessary annual expense of maintaining that harbor will continue until its abandonment is made possible by the creation of the new harbor.

Money statement.

July 1, 1900, balance unexpended	$14,980.78
June 30, 1901, amount expended during fiscal year	.27
July 1, 1901, balance unexpended	14,980.51
Amount (estimated) required for completion of existing project	235,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	200,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

Appropriations for improving Kalamazoo River, Michigan.

June 3, 1896	$5,000
March 3, 1899	10,000
Total	15,000

N N 7.

IMPROVEMENT OF HARBOR AT HOLLAND (BLACK LAKE), MICHIGAN.

The last annual report is contained in Report of the Chief of Engineers for 1900, page 3891.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1901.

Soundings made April 13–15 showed that the channel had again shoaled to a depth of 10.5 feet at the entrance, with but little more inside. The available funds consisted of the balance of the general appropriation and of an allotment of $1,000 from the emergency river and harbor act of June 6, 1900. These funds have been expended in dredging to restore a navigable channel of 13 feet depth under formal contract with Samuel O. Dixon, of Milwaukee, Wis. A total of 20,702 cubic yards was dredged between May 21 and June 15, the date of completion of the work. The restored channel should endure for the rest of the present season of navigation.

CONDITION OF WORKS ON JUNE 30, 1901.

The north pier consists of 255 feet of cribwork built between 1875 and 1880 and in need of reconstruction above water, 462 feet of cribwork rebuilt during recent years with sheet piles in front, 547 feet of pile work sheet piled in front and in good condition, and of 590 feet of pile work at the inner end in wrecked condition and in need of being rebuilt at the earliest opportunity. About 50 feet of the pier at the east end is occupied by the Pere Marquette Railroad. The pier is 1,854 feet long and projects 520 feet beyond the shore line.

The south pier consists of 205 feet of cribwork built between 1875 and 1880 and in need of reconstruction above water, 345 feet of cribwork sheet piled in front, 148 feet of cribwork and 13 feet of pile work rebuilt during recent years with sheet piles in front and new superstructure, 468 feet of pile work with new sheet piling in front, and 512 feet of pile work at the inner end in need of sheet piling. The pier is 1,691 feet long and projects 685 feet beyond the shore line.

WORK PROPOSED FOR NEXT FISCAL YEAR.

Funds having been exhausted, no work can be done until a new appropriation is made by Congress.

ESTIMATE OF FUNDS FOR FISCAL YEAR ENDING JUNE 30, 1903.

The approved project provides for extending the north pier 800 feet and the south pier 700 feet. Four hundred feet of each pier should be built this year, and the estimate for this work is $85,800. Under the head of maintenance an estimate is submitted for rebuilding 1,102 linear feet of pile work in the two piers, at a cost of $27,500; rebuilding 420 linear feet of superstructure, at a cost of $7,000, and for dredging, $11,000, the total estimate for the year being $131,300.

A portion of the inner end of the north pier has been occupied by the Pere Marquette Railroad Company without authority. The company has been notified to obtain the necessary permit, and application to the Secretary of War for the same is now in preparation.

The harbor is in the collection district of Grand Haven, Mich., which place is the nearest port of entry.

Original estimated cost of the work, 1866, amended in 1873, 1879, 1884, and 1892	$291,615.31
Estimated cost of modified project of 1899	240,000.00
Whole amount expended to June 30, 1901	342,387.65

Money statement.

July 1, 1900, balance unexpended		$3,932.46
March 21, 1901, amount allotted from appropriation for emergencies in river and harbor works		1,000.00
		4,932.46
June 30, 1901, amount expended during fiscal year		4,205.99
July 1, 1901, balance unexpended		726.47
July 1, 1901, outstanding liabilities		56.33
July 1, 1901, balance available		670.14
July 1, 1901, amount covered by uncompleted contracts		372.63
Amount (estimated) required for completion of existing project		202,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance expended July 1, 1901:		
For works of improvement	$85,800.00	
For maintenance of improvement	45,500.00	
		131,300.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

Appropriations for improving harbor at Holland (Black Lake), Mich.

Black Lake:	
August 30, 1852[1]	$8,000.00
June 23, 1866	55,615.31
March 2, 1867	51,000.00
July 11, 1870	10,000.00
March 3, 1871	10,000.00
June 10, 1872	10,000.00
March 3, 1873	12,000.00
June 23, 1874	15,000.00
March 3, 1875	15,000.00
August 14, 1876	15,000.00
June 18, 1878	10,000.00
March 3, 1879	6,000.00
June 14, 1880	6,000.00
March 3, 1881	6,000.00
August 2, 1882	10,000.00
July 5, 1884	15,000.00
Black Lake—Continued:	
August 5, 1886	$5,000.00
August 11, 1888	5,000.00
September 19, 1890	10,000.00
Holland:	
July 13, 1892	5,000.00
August 18, 1894	15,000.00
June 3, 1896	10,000.00
March 3, 1899	37,500.00
June 6, 1900 (allotment)[1]	1,000.00
Total	343,115.31
Amount carried to surplus fund	1.19
	343,114.12

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[1] Allotment made for maintenance.

ABSTRACT OF CONTRACTS IN FORCE FOR IMPROVING HARBOR AT BLACK LAKE, MICHIGAN.

Dredging.

Contractor: Green's Dredging Company.
Date of contract: March 24, 1900.
Date of approval: April 12, 1900.
Date of beginning: April 29, 1900.
Date of expiration: September 30, 1900.
Rates: 16½ cents per cubic yard for dredging and $3 per mile for transfer of plant.

Contractor: Samuel O. Dixon.
Date of contract: May 1, 1901.
Date of approval: May 11, 1901.
Date of beginning: May 30, 1901.
Date of expiration: October 15, 1901.
Rate: 18 cents per cubic yard.

COMMERCIAL STATISTICS FOR HOLLAND (BLACK LAKE) HARBOR, MICHIGAN, CALENDAR YEAR ENDING DECEMBER 31, 1900.

Entrances and clearances.

Calendar year.	Number.	Tonnage.	Calendar year.	Number.	Tonnage.
1889	1,087	80,790	1895	809	210,299
1890	(*a*)	(*a*)	1896	408	269,182
1891	2,676	178,300	1897	456	153,852
1892	2,800	200,000	1898	538	163,119
1893	2,060	315,150	1899	527	(*a*)
1894	1,816	159,657	1900	862	354,718

a Not stated.

Character of vessels.

	Number.	Tonnage.
Steam	746	347,818
Sail	116	6,900
Total	862	354,718

Maximum draft, 13 feet.

Receipts and shipments by vessel, 1900.

[Compiled from statement furnished by L. T. Kanters, deputy collector of customs at Holland, Mich.]

Articles received.	Tons.	Articles shipped.	Tons.
Hay and feed	217	Furniture	3,580
Lime and cement	230	Machinery	250
Lumber	8,948	Stone	300
Shingles	676	Hay and feed	389
Laths	430	Leather and hides	4,523
Leather and hides	330	Grain and flour	550
Grain and flour	395	Farm products, miscellaneous	785
Fruit, miscellaneous	45	Fruit, miscellaneous	2,860
Merchandise, miscellaneous	21,870	Merchandise, miscellaneous	9,850
Total	33,141	Total	23,087

During the year the Pere Marquette Railroad Company established a daily steamboat line between Holland and Milwaukee to do a combined freight and passenger business. Fifteen thousand passengers were carried the first season.

N N 8.

IMPROVEMENT OF HARBOR AT GRAND HAVEN, MICHIGAN.

The last report is found in the report of the Chief of Engineers for 1900, page 3895.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1901.

Nothing was done except minor repairs to wale and timbers of superstructure of south pier at station 31+42 E., where a length of 16 feet of the pier had been injured upon November 21, 1900, by the steam barge *Robt. C. Wente.* The material for repairs was furnished by the owners of the steamer. Work was begun on June 17 and had almost been completed at the close of the year.

Funds are available for an extension of the south pier by 100 feet, but as the harbor is in good condition it will probably be wise to postpone work until funds are also made available for the extension of the north pier by 150 feet, as contemplated in the approved project.

An automatic gauge is maintained at this harbor. A record of its readings for the year is appended to this report..

CONDITIONS OF WORKS ON JUNE 30, 1901.

The piers remain as described in the last annual report, page 3896, except that the binding timber holding the screw bolts in the front wall of the pile work of the south pier between stations 20 and 25+30 has become unserviceable through age and decay, and that the filling in the south pier near shore line has settled below the water surface and permits the sand in motion along the shore to be washed through the pier into the channel.

Soundings made June 12–14 showed the following actual depths at a stage of −0.7 foot: Outside on the southern approach to the entrance, 20 feet; on the shoalest point of the bar, in front of the entrance, 14.5 feet; and on the northern approach, 19 feet. At the end of the piers the depth in the middle of the channel was 16.4 feet, with a depth of not less than 17 feet for a width of 100 feet next to the south pier. Farther in the depth increased to 20 feet and more.

WORK PROPOSED FOR NEXT FISCAL YEAR.

The repairs of the break in the south pier near station 31+42, caused by the steam barge *Wente*, will be completed.

The binder in the pile work of the south pier between stations 20 and 25+30 will be renewed, and the south pier near shore line will be refilled with stone. The cost of these repairs will be paid from the funds now available.

The channel at the harbor entrance will be improved by dredging under the contract with Samuel O. Dixon.

The remainder of the available funds will be reserved for the construction of the 100-foot extension of the south pier, which work will be postponed until funds become available for the construction of the 150 feet of extension to the north pier contemplated by the approved project.

ESTIMATE OF FUNDS FOR FISCAL YEAR ENDING JUNE 30, 1903.

To complete the project, appropriation should be made for extending north pier and for restraining the drift of sand over piers and revetments. The estimate for pier extension is $27,500.

For maintenance the estimate is as follows:

Repairing 610 feet of north pier	$10,000
Refilling piers, minor repairs, and dredging	10,000
Total	20,000

Monthly record of Grand Haven automatic gauge for the fiscal year July 1, 1900, to June 30, 1901.

[The zero of gauge is 3.06 feet below high water of 1888.]

Date.	Number of days.	Sum for month.	Monthly mean.	Highest reading.		Lowest reading.	
				Day.	Reading.	Day.	Reading.
1900.		*Feet.*	*Feet.*		*Feet.*		*Feet.*
July	31	− 30.107	−0.971	July 20	−0.30	July 7	−2.05
August	31	− 24.185	− .780	Aug. 20	+ .49	Aug. 20	−1.60
September	30	− 24.734	− .824	Sept. 11	+ .28	Sept. 28 Sept. 30	−1.30 −1.30
October	31	− 26.320	− .849	Oct. 7	− .25	Oct. 17	−1.40
November	30	− 27.473	− .916	Nov. 21	+ .18	Nov. 12	−1.65
December	31	− 38.541	−1.243	Dec. 23	− .60	Dec. 30	−2.20
1901.							
January	31	− 45.206	−1.458	Jan. 16	− .50	Jan. 26	−1.93
February	28	− 42.150	−1.505	Feb. 3	− .96	Feb. 28	−1.84
March	31	− 41.781	−1.348	Mar. 20	− .47	Mar. 3	−2.12
April	30	− 29.741	− .991	Apr. 30	− .50	Apr. 5	−1.54
May	31	− 19.038	− .614	May 23	+ .37	May 2	−1.02
June	30	− 15.213	− .507	June 25 June 28	+ .12 + .12	June 28	−1.70
Sum	365	−364.489	....	Aug. 20	+ .49	Dec. 30	−2.02

Mean daily stage for year, −364.489+365 = −0.999 foot.

On November 21, 1900, the steam barge *Robert C. Wente* collided with the south revetment near station 31 + 40, breaking the front wale and the walls of the superstructure for a length of 16 feet. The owners of the barge furnished the material for the repair of this injury and the repairs were made in June, 1901.

This harbor is the port of entry for the Grand Haven collection district.

Original estimated cost of work, 1866, amended in 1880, 1890, and 1892	$804,366.15
Whole amount expended to June 30, 1901	752,336.29

Money statement.

July 1, 1900, balance unexpended		$18,552.27
June 30, 1901, amount expended during fiscal year		1,522.41
July 1, 1901, balance unexpended		17,029.86
July 1, 1901, outstanding liabilities		195.01
July 1, 1901, balance available		16,834.85
July 1, 1901, amount covered by uncompleted contracts		2,000.00
Amount (estimated) required for completion of existing project		35,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901:		
For works of improvement	$27,500.00	
For maintenance of improvement	20,000.00	
		47,500.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

Appropriations for improving harbor of Grand Haven, Mich.

August 30, 1852 (mouth of Grand River)	$2,000.00	March 3, 1879	$9,000.00
June 23, 1866	65,000.00	June 14, 1880	50,000.00
March 2, 1867 (mouth of Grand River)	40,000.00	March 3, 1881	50,000.00
April 10, 1869 (allotment)	1,866.15	August 2, 1882	40,000.00
July 11, 1870	10,000.00	July 5, 1884	50,000.00
1870 (allotment)	500.00	August 5, 1886	30,000.00
March 3, 1871	6,000.00	August 11, 1888	25,000.00
June 10, 1872	15,000.00	September 19, 1890	75,000.00
March 3, 1873	75,000.00	July 13, 1892	90,000.00
June 23, 1874	50,000.00	August 18, 1894	25,000.00
August 14, 1876	15,000.00	June 3, 1896	20,000.00
June 18, 1878	15,000.00	March 3, 1899	10,000.00
		Total	769,366.15

ABSTRACT OF CONTRACTS IN FORCE FOR IMPROVING HARBOR AT GRAND HAVEN, MICH.

Dredging.

Contractor: Green's Dredging Company.
Date of contract: March 24, 1900.
Date of approval: April 12, 1900.
Date of beginning: April 29, 1900.
Date of expiration: September 30, 1900.
Rates: 16½ cents per cubic yard for dredging and $3 per mile for transfer of plant.

Contractor: Samuel O. Dixon.
Date of contract: May 1, 1901.
Date of approval: May 11, 1901.
Date of beginning: May 30, 1901.
Date of expiration: October 15, 1901.
Rate: 13 cents per cubic yard.

COMMERCIAL STATISTICS FOR GRAND HAVEN HARBOR, CALENDAR YEAR ENDING DECEMBER 31, 1900.

Entrances and clearances.

Calendar year.	Number.	Tonnage.	Calendar year.	Number.	Tonnage.
1888	1,508	1,405,600	1895	574	482,822
1889	1,110	649,370	1896	883	727,209
1890	1,172	834,089	1897	1,151	1,018,805
1891	819	616,422	1898	934	874,312
1892	815	693,835	1899	1,250	1,090,325
1893	761	613,425	1900	1,151	1,132,881
1894	641	504,609			

Character of vessels.

	Number.	Tonnage.
Steam	1,118	1,131,932
Sail	33	949
Total	1,151	1,132,881

Maximum draft, 17 feet.

Receipts and shipments by vessel, 1900.

[Compiled from statements furnished by the collector of customs at Grand Haven, Mich., and United States Inspector R. C. Duryea.]

Articles received.	Tons.	Articles shipped.	Tons.
Iron	36,500	Coal	150
Lime and cement	1,098	Lime and cement	562
Lumber	582	Lumber	656
Tan bark	75	Tan bark	15
Leather	41	Flour	225
Grain	13,500	Fruit, miscellaneous	594
Flour	36,488	Celery	11,100
Merchandise, miscellaneous	36,432	Fish	450
		Merchandise, miscellaneous	17,391
Total	124,711	Total	31,143

During the year the Barry line of steamers, with terminal at Chicago, and doing a daily passenger and freight business, was established.

N N 9.

IMPROVEMENT OF GRAND RIVER, MICHIGAN

The previous history of this improvement is given in report of the Chief of Engineers for 1900, page 3899.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1901.

Operations have been carried on by day labor and the use of Government plant. Dredging operations in progress at the beginning of the fiscal year were continued until November 19, when the setting in of winter forced the discontinuance of the work. Operations were resumed upon April 12, and were continued until May 9, when funds available for this work became exhausted. As a result of the dredging the single cut 30 feet wide and 6 feet deep begun in 1897 has now been carried from the upper limit of the project (about 900 feet below the Pere Marquette Railroad bridge at Grand Rapids) through all the intervening bars to Rice's bar, 23 miles below the city. In a few cases, redredging has been necessary, particularly where sand was the material of the river bed, but in most cases the cuts seem to persist. The total length of cuts dredged was 20,278 linear feet, and 72,037.35 cubic yards of sand, gravel, cobble, and bowlders were removed.

The system of longitudinal training walls has been extended, and they continue to serve efficiently their double purpose of protecting the spoil banks of adjoining dredged cuts and guiding and increasing the channel current. Forty thousand four hundred and sixty-eight linear feet of training wall were built during the year. The plant in use on this work has been extemporized from material on hand, and is ill suited for its economical prosecution.

The river is one of moderate slope and small low-water discharge. The material of the bed is usually of too large size to be much affected by even the high-water velocities, hence the method of improvement at present in use promises good results, provided the training walls efficiently protect the cuts at the localities where sand is found.

CONDITION OF WORKS ON JUNE 30, 1901.

The dredged cut has been completed from Grand Rapids to Rice's Bar, 23 miles below the city. The original depth of the cut was 6 feet, but in the case of most of the bars some shoaling has occurred. Training walls have been built to protect all cuts included in the 10 miles of river immediately below Grand Rapids, also at Lamont Bar in the seventeenth mile, and at Deer Creek Bar in the nineteenth mile. From Bass River to Grand Haven no work has been done, but no depth less than 5 feet exists.

WORK PROPOSED FOR NEXT FISCAL YEAR.

Nothing proposed, due to exhaustion of available funds.

ESTIMATE OF FUNDS FOR FISCAL YEAR ENDING JUNE 30, 1903.

The work is largely tentative and for this reason can best be done by day labor and the use of plant belonging to the United States. To materially benefit navigation and to avoid large charges for maintenance and superintendence, sufficient funds should be provided to secure an adequate plant and to prosecute the work vigorously. Nothing less than $250,000 will answer the pressing needs of the work, and an estimate for this amount is submitted. The execution of the work under contract does not seem practicable.

The Grand River Transportation Company since May 25 has maintained a regular packet service between Grand Rapids and Grand Haven. At present there are two steamers in use, giving a daily service between the two places. The larger of the two draws a little over 3 feet and seems to experience no difficulty in passing the places formerly the source of much trouble.

Original estimated cost of project adopted in 1896	$670,500.00
Whole amount expended on present project to June 30, 1901	111,663.81

Money statement.

July 1, 1900, balance unexpended	$51,486.88
June 30, 1901, amount expended during fiscal year	38,150.69
July 1, 1901, balance unexpended	13,336.19
July 1, 1901, outstanding liabilities	1,057.47
July 1, 1901, balance available	12,278.72
Amount (estimated) required for completion of existing project	545,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	250,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

Appropriations for improving Grand River, Michigan.

March 3, 1881	$10,000
August 2, 1882	15,000
July 5, 1884	25,000
June 3, 1896	50,000
March 3, 1899	75,000
Total	175,000

COMMERCIAL STATISTICS FOR GRAND RIVER, MICHIGAN, CALENDAR YEAR ENDING DECEMBER 31, 1900.

Entrances and clearances.

Calendar year.	Number.	Tonnage.	Calendar year.	Number.	Tonnage.
1896	282	46,750	1899	323	64,242
1897	77	30,390	1900	264	59,928
1898	76	86,793			

Character of vessels.

	Number.	Tonnage.
Steam	164	52,428
Scows	100	7,500
Total	264	59,928

Receipts and shipments by vessel, 1900.

[Compiled from statements furnished by United States Inspector R. C. Duryea at Grand Haven, Mich., and the Allendale Timber Company, Limited, of Grand Rapids, Mich.]

Articles received.	Tons.	Articles shipped.	Tons
Iron ore	39,775	Logs, wood, etc	5,000
		Gravel	1,500
Total	39,775	Total	6,500

REPORT OF MR. G. W. BUNKER, ASSISTANT ENGINEER.

United States Engineer Office,
Grand Rapids, Mich., July 3, 1901.

Captain: I have the honor to submit the following report on the work of improving Grand River, Michigan, under my local direction for the period from June 30, 1900, to June 30, 1901.

During the fiscal year ending June 30, 1901, the operations consisted, first, in dredging a single cut through all bars from the Glen Creek to the Haire's Bar, inclusive (except through Snyder's Bar), and through the shoalest parts of the Lamont and Deer Creek bars, and second, in contracting the stream by the construction of training walls to prevent the spoil banks from washing back into the cuts.

DREDGING.

The year's dredging operations were begun on the Glen Creek Bar (4.7 miles below Grand Rapids) on July 1, 1900, and continued until a single cut had been made through the Glen Creek, Clam Shell, Jenison, Boynton, Mack's, and Claybanks bars, and 880 feet into the Haire's Bar (10.1 miles below Grand Rapids). Cold weather and running ice in the river prevented further work and the dredge was laid up in the mouth of Jenison Creek. Dredging was stopped on November 19 and the work of laying up was completed on December 13. A watchman was left in charge during the winter.

The work of fitting out for the season of 1901 commenced April 3, and dredging operations were begun on the 12th at the head of the Lamont Bar, where a cut 1,881 feet long was made to relieve the shoalest part of the bar. A single cut through the shoalest part of the Deer Creek Bar was also made between April 21 and May 9. The funds available for dredging having been expended, the dredge was laid up at Grand Haven and the crew discharged May 27, 1901.

As a result of soundings taken during April and May, 1901, the available depths at extreme low water were found to be as follows:

Name of bar.	Available depth.		Name of bar.	Available depth.	
	On bar.	On interval between bars.		On bar.	On interval between bars.
	Feet.	*Feet.*		*Feet.*	*Feet.*
Grand Rapids to Plaster Creek Bar	....	4	Harie's Bar	3.8	6
Plaster Creek Bar	4.2	5.5	Sand Creek Bar	4.2	8
Noble Bar	5	3.5	Lowing Bar	4	7
Salt Works Bar	5.4	5	Bridge Street Bar	3.4	6
Howlett Bar	4	4.7	Lamont Bar	3.4	7
Glen Creek Bar	4.9	5	Trail Creek Bar	3.8	7
Clam Shell Bar	5.2	5.8	Deer Creek Bar	3	5
Jenison Bar	4.6	5.6	Eastmanville Bar	4.2	5
Snyder Bar	5.7	6.4	County House Bar	4	7
Boynton Bar	4.6	6.8	Rice's Bar	4	....
Mack's Bar	5.5	6.8	From Rice's Bar to Grand Haven	....	5
Claybanks Bar	3.5	6.8			

NOTE.—The depths given in this table are soundings taken on the shoalest part of each bar, and are not indicative of the mean depth on the bar. A very small amount of dredging on each shoal place would make the available depths from 1 to 3 feet greater.

Dredging from June 30, 1900, to June 30, 1901.

Name of bar.	Distance from Grand Rapids.	Length of cut.	Amount dredged.	Material.
	Miles.	*Feet.*	*Cubic yds.*	
Glen Creek	4	1,496	9,184.3	Sand.
Clam Shell	5	1,305	4,955.25	Do.
Jenison	6	3,694	15,435.71	Sand, clay, bowlders, cobble, and gravel.
Boynton	8	2,369	8,488.41	Sand, bowlders, and cobble.
Macks	9	1,529	4,275.28	Sand and cobble.
Claybanks	9–10	3,870	9,817.16	Gravel.
Haires	11	880	2,241.24	Do.
Lamont	16–17	1,881	5,780.52	Sand.
Deer Creek	19–20	3,254	11,859.48	Do.
Total	....	20,278	72,037.35	

CONTRACTION WORKS.

The contraction works (consisting of training walls) which where built during the past fiscal year are a continuation of the works of previous years. Their nature and beneficial effects have been described in the Annual Reports of the Chief of Engineers for 1899 and 1900.

The work in progress at the close of the last fiscal year was continued throughout the navigable season. At the close of the calendar year, 34,732 linear feet of training wall had been built between the first and tenth miles below Grand Rapids and on the Lamont Bar, and the necessary repairs made to the works of previous years. The work was stopped by cold weather and high water on November 27, and the outfit was laid up for the winter in the mouth of Jenison Creek.

During the winter close watch was kept of the works to prevent their destruction by ice, with the result that only slight damage was sustained.

The work of fitting out in the spring was begun May 27, and at the close of the fiscal year 1901, June, 30, 5,736 linear feet of training wall had been built on the Deer Creek Bar (19 miles below Grand Rapids), making a total for the fiscal year of 40,468 linear feet of wall built.

Through surveys a close study of the results of their construction has been made and the following facts deduced, viz:

1. They should be closed with the bank at their upper end, and sufficiently open at their lower end to allow the free passage of any water which may seep through them. This arrangement allows the water in the rear of the wall to fall below that

in the channel, and during the high stages the water runs through and over the tops of the walls, and as it strikes the more sluggish water in the rear it drops its load. These accretions sometimes amount to 2 or 3 feet in a season.

2. They should reduce the cross section of the navigable portion of the stream to a width varying from 140 to 180 feet. Experience shows that these widths, under prevailing conditions, will usually maintain the original depth and sometimes produce the scouring effect, without increasing the current enough to be a serious drawback to navigation.

3. The tops of the walls should not be higher than 1 foot above extreme low water. The theoretical advantage of a high wall (2 or 3 feet above low water) is that to make the wall high would prolong its confining effect and give the stream a longer time in which to scour the bottom. Practical experience, however, teaches that the disadvantages of the high wall outweigh the advantages. Some of these disadvantages are as follows: (1) It costs from one-third to one-half more in material to build the average wall with its top 3 feet above low water than it does to built it 1 foot above the same elevation; (2) the life of the material more than 1 foot above low water is not over three years while the life of that below that elevation is indefinitely long; (3) the mean stage of the water during the winter season when ice covers the river is approximately 2 feet above low water. A wall whose top is 1 foot or less in height will escape the lifting and shoving effect of the ice, while the one whose top is 3 feet high would be seriously injured if not destroyed. Walls which where at first built 2 or 3 feet high have since been cut down, and the effect of the ice upon them during the past winter has justified the change.

PLANT.

The plant in use on the river during the fiscal year is as follows:

1. U. S. dipper dredge *Farquhar*.
2. United States sand-pump dredge (which is being used to construct training walls).
3. U. S. gasoline launch *Engineer* (formerly *Bertha S.*).
4. Grand River scows *Nos. 1* and *2*.

Repairs to plant.—All repairs, except those made to the machinery which required the appliances of a machine or boiler shop, were made by the regular crew while fitting out or laying up.

Amount and cost of dredging for fiscal year ending June 30, 1901.

Total length of cut	feet	20,278
Number of cubic yards dredged		72,037.35
Total amount expended on dredging during the year		$8,557.53
Cost per cubic yard dredged		$0.1187

Amount and cost of training walls for fiscal year ending June 30, 1901.

40,468 linear feet of wall built, costing	$13,661.10
21,897 linear feet of wall repaired, costing	608.31
Material on hand not in work June 30, costing	9,675.43
Cost of constructing training wall, per foot	.337
Cost of repairing training wall, per foot	.027

Division of expenditures for fiscal year ending June 30, 1901.

Dredging	$8,557.53
Contraction works	23,944.84
Surveys, superintendence, office expenses, and contingencies	5,648.32
Total	38,150.69

Very respectfully, your obedient servant,

G. W. Bunker,
Assistant Engineer.

Capt. Charles Keller,
Corps of Engineers, U. S. A.

N N 10.

IMPROVEMENT OF HARBOR AT MUSKEGON, MICHIGAN.

The record of the improvement is brought to the beginning of the year in the Report of the Chief of Engineers for 1900, page 3905.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1901.

Dredging, under contract with Green's Dredging Company, in progress at the beginning of the year, was completed, with the result that a channel not less than 15 feet deep at the prevailing stage was created by the removal of 14,988 cubic yards.

Examination on April 8–9 having shown that this channel had shoaled to 13 feet, by authority of the Chief of Engineers an emergency agreement with Bennett & Schnorbach was made for the minimum amount of dredging that would restore a practicable 15-foot channel. Under this agreement 2,346 cubic yards of material were removed between April 19 and 29.

Operations under the contract with McLeod & Newcombe, of Muskegon, Mich., for extending the north pier 200 feet and the south pier 100 feet, were continued. This contract was to have been completed upon December 1, 1900, but has since been twice extended, the present time of completion being August 1, 1901. Progress has been very unsatisfactory. At the close of the year the two cribs for the north pier were in place and their superstructure partly completed, the crib for the south pier had been completed, but was not yet in place, and 16 of its foundation piles had been driven. Upon June 17, 1901, the steamer *State of Michigan* during a fog ran into the end of the north pier, badly damaging it. The cost of repair, under the contract, falls upon the contractor.

On October 27, 1900, the steamer *F. & P. M. No. 1*, of the Barry Line, while entering the harbor during a fog, ran into the south pier on the channel side, near station 15, and broke the upper six courses of the side wall and three cross timbers. No repairs have as yet been made.

Parts of the north pier and north revetment, being in danger of immediate destruction, were repaired under emergency agreement with Bennett & Schnorbach, of Muskegon, Mich.

A detailed description of operations is contained in the following extract from the report of Assistant Engineer F. W. Lehnartz:

The dredging for the restoration of the required width and depth of channel under the contract with Green's Dredging Company, which had been commenced on June 27, 1900, was temporarily suspended on July 5, as the dredge was urgently needed at Saugatuck Harbor. On August 4 operations were again resumed and continued until September 1. They consisted in deepening the hoal area in front of the entrance for a length varying from 70 to 160 feet and for a width of 225 feet, removing the shoal in the channel opposite the outer end of the north pier for a length of about 200 feet and width of 125 feet and widening the channel between stations 0+80 and 12+60. The bottom of all the cuts was 20 feet below zero of gauge, and the quantity dredged after July 1 measured 14,988 cubic yards. The result was a navigable channel not less than 17 feet deep between the projecting parts of the piers and not less than 15 feet deep inside.

At the time of the opening of navigation in 1901 complaints reached this office that the channel was seriously obstructed by shoals formed during the winter, and an examination made April 8–9 showed that the available depth on a straight course between pier stations 4 and 11 was reduced to 13 feet, while the channel at other places was quite narrow. As the dredges to be employed under the general contract for the dredging to be done in 1901 were not yet available, a special agreement was entered into with Bennett & Schnorbach, of Muskegon, for the preliminary deepening of the channel in the worst place, which was done between April 19 and 29, resulting in the restoration of 15 feet of water and in the removal of 2,346 cubic yards of material.

Contractors McLeod & Newcombe continued operations for extending the north pier 200 feet and the south pier 100 feet. During the remainder of the season of 1900 cribs 1 and 2, each 100 by 30 by 20½ feet, for the north pier extension, and 14 courses of the crib for the south pier were constructed, and crib No. 1 was sunk in its place and partly filled with stone. Operations were suspended November 23 for the winter, and when they were resumed on April 17 it was discovered that crib No. 1, which had been left without superstructure, had lost a large part of its filling, either from the drainage through the open bottom of the side pockets or from being washed overboard by the sea. The crib was refilled from the first cargo of stone received at the harbor, and thereby made secure. The foundation piles of north pier crib 2, having been sawed off in a hurried manner and without strict regard to grade, were resawed at the proper elevation where too high; 7 piles which had been sawed off too low were leveled up by means of iron caps of the required thickness, and 7 new piles were driven to take the place of such as were out of line or otherwise defective. This crib was sunk in its place on June 11, and parts of the first 5 courses of superstructure over the 2 new cribs, varying in length from 148 to 112 feet, have been built. The construction of the new crib for the south pier, 100 by 30 by 22½ feet, has been completed, and 16 of its foundation piles have been driven.

On June 17 the steamer *State of Michigan*, while entering the harbor in a fog, ran into the outer end of the new end crib in the north pier and damaged it seriously, cutting through the six upper courses of the end wall and breaking the upper eight courses of the south side wall for distances of 13 to 20 feet from the outer end. The crib will be repaired in a substantial manner without cost to the United States.

During the storms of the fall of 1900 the north revetment, in front of the life-saving station, between stations 4+26 and 5 E., and the north pier, between stations 0 and 0+32 W., were undermined, and these parts were in immediate danger of being washed out. To prevent their total destruction, they were strengthened with 12 piles driven close to the channel wall between stations 4 + 26 and 5 E. and with 4 piles between stations 0 and 0+32 W., and secured to the same by screw bolts. This work was done in November and December under special agreement with Bennett & Schnorbach, of Muskegon.

CONDITION OF WORKS ON JUNE 30, 1901.

The two piers remain as stated in the annual report for 1900, page 3906, except that 200 feet of crib work, with the superstructure as yet incomplete, have been added to the north pier. The north pier projects 1,380 feet beyond the shore line and the south pier 1,410 feet. The sheet-pile revetment and 30 feet of the crib work in the north pier have suffered additional damage from being undermined, and another hole about 12 feet long and reaching from the top of the work to the water line has been made in the channel wall of the south pier, near station 15, by the steamer *F. & P. M. No. 1*, of the Barry Line, on October 27. The filling in many pockets in the south pier crib work has settled greatly.

Comprehensive soundings made June 5–11, at a stage of —1.2 feet, showed a depth of 25 feet outside on line with the south pier and a depth of 19 feet for a width of 100 feet at the end of the piers. The middle of the entrance was occupied by a shoal with only 14.4 feet water. Inside the available depth was 15 feet.

WORK PROPOSED FOR NEXT FISCAL YEAR.

The pier extension now under contract with McLeod & Newcombe will be completed, and dredging under contract with Samuel O. Dixon will be done to the extent permitted by available funds.

ESTIMATE OF FUNDS FOR FISCAL YEAR ENDING JUNE 30, 1903.

The present project provides for additional pier extension of 350 feet to the north pier and 200 to the south pier, the cost of which will be $72,600.

The estimate for maintenance is:

Repair 304 feet of south pier	$6,700
Refilling piers and minor repairs	2,700
Dredging	6,600
Total	16,000

House Ex. Doc. No. 104, Fifty-sixth Congress, second session, contained a project for a channel "of the depth of 20 feet and a uniform width of 300 feet from the exterior to the interior lake, the plan to provide for sheet piling to prevent erosion along the banks not protected by cribs." In case this project should meet the approval of Congress, the work most urgently needed is the sheet-piling revetment for the protection of the banks of the inner part of the channel.

The harbor is in the Grand Haven collection district, and the nearest port of entry is Grand Haven, Mich.

Original estimated cost of work, 1866, amended in 1869, 1873, 1881, 1884, 1890, 1892, and 1899	$596,600.00
Whole amount expended to June 30, 1901	493,768.54

Money statement.

July 1, 1900, balance unexpended		$44,531.30
March 21, 1901, amount allotted from appropriation for emergencies in river and harbor works, act of June 6, 1900		2,500.00
		47,031.30
June 30, 1901, amount expended during fiscal year		14,299.84
July 1, 1901, balance unexpended		32,731.46
July 1, 1901, outstanding liabilities		60.25
July 1, 1901, balance available		32,671.21
July 1, 1901, amount covered by uncompleted contracts		30,904.48
Amount (estimated) required for completion of existing project		72,600.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901:		
For works of improvement	$72,600.00	
For maintenance of improvement	16,000.00	
		88,600.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

Appropriations for improving harbor at Muskegon, Mich.

March 2, 1867	$59,000	July 5, 1884	$20,000
July 11, 1870	10,000	August 5, 1886	12,500
March 3, 1871	15,000	August 11, 1888	45,000
June 10, 1872	10,000	September 19, 1890	50,000
June 23, 1874	10,000	July 13, 1892	75,000
March 3, 1875	25,000	August 18, 1894	30,000
August 14, 1876	15,000	June 3, 1896	30,000
March 3, 1879	5,000	March 3, 1899	60,000
June 14, 1880	7,500	June 6, 1900 (allotment)[1]	2,500
March 3, 1881	20,000		
August 2, 1882	25,000	Total	526,500

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[1] Allotment made for maintenance.

ABSTRACT OF CONTRACTS IN FORCE FOR IMPROVING HARBOR AT MUSKEGON, MICH.

Dredging.

Contractor: Green's Dredging Company.
Date of contract: March 24, 1900.
Date of approval: April 12, 1900.
Date of beginning: April 29, 1900.
Date of expiration: September 30, 1900.
Rates: 16½ cents per cubic yard for dredging and $3 per mile for transfer of plant.

Contractor: Samuel O. Dixon.
Date of contract: May 1, 1901.
Date of approval: May 11, 1901.
Date of beginning: May 30, 1901.
Date of expiration: October 15, 1901.
Rate: 13 cents per cubic yard.

Pier extension.

Contractors: McLeod & Newcombe.
Date of contract: February 5, 1900.
Date of approval: February 28, 1900.
Date of beginning: May 1, 1900.
Date of expiration: December 1, 1900; extended to July 1, 1901, and August 1, 1901.

Rates: Dredging, at 80 cents per cubic yard; foundation piles, at 50 cents per linear foot; white-oak guard piles, at 50 cents per linear foot; white-oak timber, at $50 per M feet B. M.; white-pine timber, at $30 per M feet B. M.; hemlock timber, at $26 per M feet B. M.; white-pine plank, at $26 per M feet B. M.; driftbolts, screw bolts, and spikes, at 4 cents per pound; stone, at $7 per cord.

COMMERCIAL STATISTICS FOR MUSKEGON HARBOR, MICHIGAN, CALENDAR YEAR ENDING DECEMBER 31, 1900.

Entrances and clearances.

Calendar year.	Number.	Tonnage.	Calendar year.	Number.	Tonnage.
1888	2,683	....	1895	887	441,289
1889	4,626	884,869	1896	981	562,757
1890	3,786	649,540	1897	1,244	725,514
1891	2,886	704,046	1898	1,508	1,165,802
1892	4,174	740,021	1899	1,545	1,234,193
1893	2,482	834,049	1900	1,366	904,636
1894	1,423	793,184			

Character of vessels.

	Number.	Tonnage.
Steam	1,161	884,024
Sail	205	20,612
Total	1,366	904,636

Maximum draft, 15 feet.

Receipts and shipments by vessel, 1900.

[Compiled from statement furnished by K. M. Lee, deputy collector of customs at Muskegon, Mich.]

Articles received.	Tons.	Articles shipped.	Tons.
Coal	622	Coal	1,708
Iron	5,783	Iron	7,753
Machinery	757	Machinery	298
Lime and cement	415	Lime and cement	2,506
Lumber	21,413	Lumber	45,978
Shingles	325	Laths	75
Laths	1,884	Tan bark	1,958
Tan bark	1,995	Leather	55
Leather	30	Paper	341
Paper	598	Potatoes	60
Grain	34,500	Fruit, miscellaneous	786
Potatoes	56	Flour	466
Flour	3,111	Merchandise, miscellaneous	76,733
Merchandise, miscellaneous	57,917		
Total	129,406	Total	138,717

During the year a new line of steamboats was established between Muskegon and Chicago, doing a general shipping and passenger business and giving daily service.

N N 11.

IMPROVEMENT OF HARBOR AT WHITE LAKE, MICHIGAN.

The history of this improvement is brought to the beginning of the present year in the Report of the Chief of Engineers for 1900, page 3909.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1901.

Dredging for maintenance was done under contract with Green's Dredging Company, of Chicago, Ill., between September 5 and 18, 1900. The removal of 5,802 cubic yards produced a good channel of 12.5 feet minimum depth, and soundings made this spring show that this depth has been maintained.

Under contract with Smith & Nelson, of Muskegon, Mich., the north pier was extended by two cribs, each 100 by 24 by 14½ feet, capped by a 6-foot superstructure, and the south pier by one crib 100 by 30 by 18½ feet, with 6-foot superstructure, while the inner end crib of the south pier was also repaired. Owing to the wrecking of their stone scows the contractors were unable to complete their contract before December 1, 1900, as specified, and the time of completion was extended by the Chief of Engineers to July 1, 1901. Work was actually finished upon May 11, 1901.

These operations are described in detail in the following extract from the report of Assistant Engineer F. W. Lehnartz:

Contractors Smith & Nelson continued the work begun in the previous fiscal year of extending the north pier 200 feet and the south pier 100 feet. The extension of the north pier consists of two cribs, each 100 feet long, 24 feet wide, and 14½ feet deep, and that of the south pier of one crib 100 feet long, 30 feet wide, and 18½ feet deep, with a superstructure 6 feet high in both cases. All the cribs rest on a pile foundation. The north pier cribs were sunk in their places on September 8 and 27, and the south pier crib on October 15. At the end of the working season of 1900 the superstructure was completed in both piers, the guard piles at the outer end and the horizontal fender timbers above water between the end horns were in place, as were also the mooring posts, 50 feet apart, but the structures still needed about 140 cords of stone to fill them. Owing to the sinking of their stone scows in Sturgeon Bay Canal the contractors were unable to procure the required filling in time, and operations were suspended on December 15, the structures having previously been protected with a temporary deck for their security during the winter. On May 6 the contractors resumed operations, and completed the same on May 11 by filling the new work to the top and putting on the decking. The extension of the south pier involved the repairs of the former end crib, which had settled badly at the outer end and had lost several courses of timber from the end wall and from the outer portion of the two side walls below the water surface. The repairs consisted in cutting out the timbers above the break, leveling up the substructure, and extending the superstructure of the new crib so as to cover the old crib and give the top of the structure practically the same level throughout. The repaired crib was also filled with stone and decked over.

At the beginning of the fiscal year the entrance of the channel was obstructed by a shoal projecting from the north around the end of the north pier. To improve this condition the dredge of Green's Dredging Company widened the channel at the entrance by three adjacent cuts, each 25 feet wide and 16 feet deep below the level of zero of gauge. This work was done between September 5 and 18, resulting in the removal of 5,802 cubic yards sand and in the restoration of a straight channel with a depth of not less than 12.5 feet.

The soundings of May 9 to 11 showed an available depth of 15 feet outside on line with the south pier, 16 feet at end of piers, and 12.7 feet inside, the stage at the time being —0.7 feet.

CONDITION OF WORKS ON JUNE 30, 1901.

The north pier consists of 1,515 feet of pile work and 200 feet of crib work, has a total length of 1,715 feet, and projects 500 feet beyond the shore line. The crib work is new and in good condition. Forty-five linear feet of the pile work at its outer end is unsafe and requires radical repairs. The filling in the remaining pile work is in bad condition and needs overhauling and renewal.

The south pier consists of 1,498 feet of pile work and 455 feet of crib work, has a total length of 1,953 feet, and projects 790 feet beyond the shore line. Three hundred and fifty feet of the crib work is in good condition, 100 feet being new and 250 feet having been repaired during the last two years. The remaining portion of 105 feet is 18 years old and will need rebuilding above water before long. Three hundred and seventy-one feet of the pile work is in good condition. The filling in the inner portion of the pile work, 1,127 feet in length, has badly settled and needs overhauling and renewal.

WORK PROPOSED FOR NEXT FISCAL YEAR.

Owing to the exhaustion of funds, no work is proposed.

ESTIMATE OF FUNDS FOR FISCAL YEAR ENDING JUNE 30, 1903.

To complete existing project, by extending north pier 50 feet and south pier 100 feet, will require $18,100. For maintenance the estimate is as follows: Reconstruction, 45 feet north pier; new superstructure, 100 feet south pier, and refilling in both piers, $13,100; dredging, $4,400; total, $17,500.

The harbor is in the Grand Haven collection district, and the nearest port of entry is Grand Haven, Mich.

Original estimated cost of work, 1866, amended in 1873, 1884, 1892, and 1898	$353,550.00
Whole amount expended to June 30, 1901	323,935.71

Money statement.

July 1, 1900, balance unexpended		$31,332.23
June 30, 1901, amount expended during fiscal year		30,717.94
July 1, 1901, balance unexpended		614.29
July 1, 1901, outstanding liabilities		482.68
July 1, 1901, balance available		131.61
Amount (estimated) required for completion of existing project		29,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901:		
For works of improvement	$18,100.00	
For maintenance of improvement	17,500.00	
		35,600.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

Appropriations for improving harbor at White Lake, Mich.

March 2, 1867	$57,000	March 3, 1881	$7,500
April 10, 1869 (allotment)	44,550	August 2, 1882	12,000
July 11, 1870	20,000	July 5, 1884	10,000
March 3, 1871	20,000	August 5, 1886	10,000
June 10, 1872	10,000	August 11, 1888	10,000
March 3, 1873	7,000	September 19, 1890	17,000
June 23, 1874	10,000	July 13, 1892	5,000
March 3, 1875	10,000	August 18, 1894	5,000
August 14, 1876	5,000	June 3, 1896	5,000
June 18, 1878	12,000	March 3, 1899	35,000
March 3, 1879	7,500		
June 14, 1880	5,000	Total	324,550

ABSTRACT OF CONTRACTS IN FORCE FOR IMPROVING HARBOR AT WHITE LAKE, MICHIGAN.

Dredging.

Contractor: Green's Dredging Company.
Date of contract: March 24, 1900.
Date of approval: April 12, 1900.
Date of beginning: April 29, 1900.
Date of expiration: September 30, 1900.
Rates: 16½ cents per cubic yard for dredging and $3 per mile for transfer of plant.

Extension and repair of piers.

Contractors: Smith & Nelson.
Date of contract: March 8, 1900.
Date of approval: March 22, 1900.
Date of beginning: May 1, 1900.
Date of expiration: December 1, 1900; extended to July 1, 1901.
Rates: Dredging, at 40 cents per cubic yard; foundation piles, at 50 cents per linear foot; white-oak guard piles, at 50 cents per linear foot; white-oak timber, at $50 per M feet B. M.; white pine timber, at $30 per M feet B. M.; hemlock timber, at $23 per M feet B. M.; white pine plank, at $26 per M feet B. M.; drift bolts, screw bolts, and spikes, at 4 cents per pound; stone, at $7.25 per cord.

COMMERCIAL STATISTICS.

Entrances and clearances.

Calendar year.	Number.	Tonnage.	Calendar year.	Number.	Tonnage.
1888	1,408	147,142	1895	281	34,574
1889	782	....	1896	245	27,962
1890	579	62,276	1897	247	33,409
1891	405	47,135	1898	175	16,415
1892	392	58,950	1899	....	....
1893	260	1,052,026	1900	....	....
1894	195	18,115			

Maximum draft, 12.7 feet.

No data relative to commercial statistics for calendar year ending December 31, 1900, could be obtained.

N N 12.

IMPROVEMENT OF HARBOR AT PENTWATER, MICHIGAN.

The account of this improvement is brought to July 1, 1900, in the report of the Chief of Engineers for 1900, page 3913.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1901.

No work was done, owing to lack of funds.

CONDITION OF WORKS JUNE 30, 1901.

This is as described in last annual report. The 912 feet of pile work therein referred to is, however, now a complete wreck, and much additional filling will be required.

WORK PROPOSED FOR NEXT FISCAL YEAR.

Nothing proposed, owing to lack of funds.

ESTIMATE OF FUNDS FOR FISCAL YEAR ENDING JUNE 30, 1903.

The approved project provides for an extension of 200 feet to the south pier, the estimated cost being $22,000. To insure the proposed 12-foot channel, further extensions of both piers will, however, be necessary. Under the head of maintenance, provision should be made for dredging, for repairing end crib of north pier and 912 feet of north revetment, and for refilling piers and revetments with brush and stone. The estimate for these purposes is $32,600.

The harbor is in the collection district of Grand Haven, Mich., which place is the nearest port of entry.

Original estimated cost of work, 1867, amended in 1873, 1884, and 1892..	$327,713.40
Whole amount expended to June 30, 1901	272,468.40

Money statement.

July 1, 1900, balance unexpended		$1,693.77
June 30, 1901, amount expended during fiscal year		342.17
July 1, 1901, balance unexpended		1,351.60
July 1, 1901, outstanding liabilities		28.08
July 1, 1901, balance available		1,323.52
Amount (estimated) required for completion of existing project		53,893.40
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901:		
For works of improvement	$22,000.00	
For maintenance of improvement	32,600.00	
		54,600.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

Appropriations for improving harbor at Pentwater, Mich.

March 2, 1867	$55,000	August 2, 1882	$10,000
April 10, 1869 (allotment)	17,820	July 5, 1884	15,000
July 11, 1870	10,000	August 5, 1886	10,000
March 3, 1871	10,000	August 11, 1888	8,000
June 10, 1872	30,000	September 19, 1890	8,000
March 3, 1873	20,000	July 13, 1892	5,000
August 14, 1876	10,000	August 18, 1894	5,000
June 18, 1878	10,000	June 3, 1896	5,000
March 3, 1879	6,000	March 3, 1899	25,000
June 14, 1880	4,000		
March 3, 1881	10,000	Total	273,820

ABSTRACT OF CONTRACTS IN FORCE FOR IMPROVING HARBOR AT PENTWATER, MICH.

Dredging.

Contractor: Green's Dredging Company.
Date of contract: March 24, 1900.
Date af approval: April 12, 1900.
Date of beginning: April 29, 1900.
Date of expiration: September 30, 1900.
Rates: 16½ cents per cubic yard for dredging and $3 per mile for transfer of plant.

COMMERCIAL STATISTICS FOR PENTWATER HARBOR, MICHIGAN, CALENDAR YEAR ENDING DECEMBER 31, 1900.

Entrances and clearances.

Calendar year.	Number.	Tonnage.	Calendar year.	Number.	Tonnage.
1888	300	45,000	1895	500	(*a*)
1890	27	2,559	1898	1,208	108,253
1891	1,140	71,260	1899	(*a*)	(*a*)
1893	116	(*a*)	1900	(*a*)	31,721
1894	60	(*a*)			

a Not stated.

Character of vessels.

	Number.	Tonnage.
Steam	Not given	26,726
Sail	do	4,995
Total		31,721

Maximum draft, 11.8 feet.

Receipts and shipments by vessels, 1900.

[Compiled from statement furnished by the president of the village of Pentwater, Mich.]

Articles received.	Tons.	Articles shipped.	Tons.
Logs	11,948	Wood	1,421
Cedar posts	48	Lumber	11,127
Salt	182	Potatoes	82
Lime	59	Shingles	1,456
Corn	119	Bark	720
Oats	151	Cedar posts	749
Lumber	781	Ties	910
Total	13,288	Total	16,465

N N 13.

IMPROVEMENT OF HARBOR AT LUDINGTON, MICHIGAN.

The account of this improvement to the beginning of the fiscal year is found in the Report of the Chief of Engineers for 1900, page 3916.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1901.

Operations under the contract with Nelson J. Gaylord, dated July 10, 1899, and finally extended to December 31, 1900, for the repair of 444 linear feet of north pier and 303 linear feet of south pier, were continued and finally completed upon November 24. As a result these portions of the piers have been rendered sand tight by means of triple lap sheet piling, and their superstructure renewed. The details of these repairs are shown in the drawing accompanying the annual report for 1899, page 2937.

The inner end of the south pier was repaired for a distance of 30 feet which had been damaged.

Soundings made May 14–15 having shown that the existing channel, while of the requisite depth of 18 feet, had been narrowed by shoals, dredging under contract with Samuel O. Dixon, of Milwaukee, Wis., was begun on June 19, and at the close of the year the necessary width had nearly been restored.

The appended extract from the report of Assistant Engineer F. W. Lehnartz shows the details of these operations:

At the beginning of the fiscal year a contract was in force with Nelson J. Gaylord for the reconstruction of the north pier between stations 5 + 88 and 10 + 32 and of the south pier between stations 5 + 67 and 8 + 70, but very little progress had been made before July 1. The contract having been further extended from July 31, 1900, to December 31, 1900, the operations were pushed more energetically after the beginning of August, and the work was finally completed November 24. Considerable delay was caused by the damage to the incompleted work through several severe storms, which occasioned extensive repairs. The reconstruction of both piers consisted in cutting down the old structures to the level of the zero gauge, driving a row of triple sheet piles, protected in front by oak round piles, along the channel wall, connecting the sheet and round piles by means of a front wale, binding timbers, screw bolts and tie-rods with the old work, building a new superstructure 4 feet high on top, the front wall resting on the new round piles, and the rear wall on the rear wall of the old substructure, replacing the old stone filling, and putting on a walk 3 feet wide of 3 by 12 inch planks. The triple sheet piling consists of 4-inch, 3-inch, and 2-inch white-pine planks, fastened together by means of carriage bolts, and they are 26 feet long in the work with the top 2 inches above zero of gauge. The round front piles are 4 feet from center to center and 33 feet long in the work with the top at zero of gauge.

The inner end of the south pier, which had been damaged for a length of about 30 feet, was temporarily strengthened by driving 7 new piles in the front wall, 3 piles in the rear wall, connecting them by means of wales and tie-rods, and refilling the pier with 15 cords brush and 3 cords stone.

Soundings made May 14–15, at a stage of —0.8 foot showed an available depth outside of 18 feet, and between the piers of 18.5 feet, but the channel was narrowed at the entrance by a shoal overlapping the end of the north pier, and inside by shoal reaches along the two piers. To improve this condition the dredge of Contractor Samuel O. Dixon commenced dredging on June 19, and at the end of the fiscal year the shoal reach beyond the end of the north pier had been deepened to 21 feet below zero of gauge, the projecting shoal opposite north pier station 17 to 19 had been removed, and 1,290 linear feet of a cut along the front of the south pier had been made. The depth of cuts between the piers was 20 feet below zero of gauge. The amount dredged from June 19 to 30 was 12,976 cubic yards.

CONDITION OF WORKS ON JUNE 30, 1901.

The north pier, entirely of crib work, is 1,452 feet long and projects 860 feet beyond the shore line. Six hundred and fifty-one feet is sheet piled on the channel side. The part from stations 12+39 to 14+89 is 21 to 26 years old and needs rebuilding. The remainder of the pier is in good condition except that the timbers of the front wall have been somewhat bruised by the steamers of the Pere Marquette Railroad.

The south pier, 567 feet of pile work and 1,814 feet of crib work, has a total length of 2,381 feet and projects 1,490 feet beyond the shore line. Six hundred and six feet of the crib work is sheet piled on the channel side. The pile work is a total wreck and needs rebuilding. The crib work from stations 11+73 to 16+80 is from 19 to 27 years old, and must be rebuilt above water and partly sheet piled. The remainder of the pier is in good condition except for numerous breaks in the timbers of the channel wall above water, caused by collisions of the steamers of the Pere Marquette Railroad.

The old slab revetment which formerly protected the north side of the channel, just east of the Government pier has been totally destroyed and the bank has been badly eroded by the waves from the channel. The north pier should be extended east about 590 feet for the protection of this bank.

WORK PROPOSED FOR NEXT FISCAL YEAR.

Dredging under the contract with Samuel O. Dixon will be completed. No other work is proposed.

ESTIMATE OF FUNDS FOR FISCAL YEAR ENDING JUNE 30, 1903.

The present project provides for extending the north pier 700 feet and the south pier 300 feet. One-half of this work can be advantageously accomplished in one season and will cost $69,300. The project includes also items of maintenance covering repairs to be made as follows:

Repairing 99 linear feet of north pier	$2,725
Repairing 817 feet of south pier	23,175
Total	25,900

The estimate for maintenance not included in the above portion of the project is as follows:

Repairing 151 feet north pier and 257 feet south pier	$6,800
Replacing north revetment, 588 feet	16,200
Dredging	7,700
Total for maintenance	30,700

The harbor is in the Grand Haven, Mich., collection district, which is the nearest port of entry.

Original estimated cost of work, 1867, revised in 1890	$381,682.00
Estimated cost of modified project adopted in 1899	210,000.00
Whole amount expended to June 30, 1901	406.056.81

Money statement.

July 1, 1900, balance unexpended		$24,956.08
June 30, 1901, amount expended during fiscal year		17,578.79
July 1, 1901, balance unexpended		7,377.29
July 1, 1901, outstanding liabilities		107.92
July 1, 1901, balance available		7,269.37
July 1, 1901, amount covered by uncompleted contracts		3,000.00
Amount (estimated) required for completion of existing project		185,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901:		
For works of improvement	$95,200.00	
For maintenance of improvement	30,700.00	
		125,900.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

Appropriations for improving harbor at Ludington, Mich.

March 2, 1867	$50,000.00	July 5, 1884	$10,000.00
April 10, 1869 (allotment)	31,185.00	August 5, 1886	56,250.00
July 11, 1870	10,000.00	August 11, 1888	60,000.00
March 3, 1871	10,000.00	July 13, 1892	5,000.00
June 10, 1872	10,000.00	August 18, 1894	6,000.00
March 3, 1873	25,000.00	June 3, 1896	25,000.00
June 23, 1874	20,000.00	March 3, 1899	25,000.00
March 3, 1875	10,000.00		
August 14, 1876	10,000.00	Total	413,435.00
June 18, 1878	15,000.00	Amount carried to the surplus fund, 1872	.90
March 3, 1879	5,000.00		
June 14, 1880	8,000.00		
March 3, 1881	10,000.00		413,434.10
August 2, 1882	12,000.00		

ABSTRACT OF CONTRACTS IN FORCE FOR IMPROVING HARBOR AT LUDINGTON, MICHIGAN.

Dredging.

Contractor: Green's Dredging Company.
Date of contract: March 24, 1900.
Date of Approval: April 12, 1900.
Date of beginning: April 29, 1900.
Date of expiration: September 30, 1900.
Rates: 16½ cents per cubic yard for dredging and $3 per mile for transfer of plant.

Contractor: Samuel O. Dixon.
Date of contract: May 1, 1901.
Date of approval: May 11, 1901.
Date of beginning: May 30, 1901.
Date of expiration: October 15, 1901.
Rate: 18 cents per cubic yard.

Repair of piers.

Contractor: Nelson J. Gaylord.
Date of contract: July 10, 1899.
Date of approval: July 21, 1899.
Date of beginning: August 8, 1899.

Date of expiration: December 1, 1899; extended to July 31, 1900, November 15, 1900, and December 31, 1900.

Rates: Cutting down old work, at $1.50 per linear foot; white-oak round piles, at 33 cents per linear foot; white-oak timber, at $40 per thousand feet B. M.; white pine timber, at $25 per thousand feet B. M.; white-pine plank sheet piles, at $34 per thousand feet B. M.; white-pine plank decking, at $20 per thousand feet B. M.; drift-bolts, screw bolts, and tie-rods, at 3½ cents per pound; carriage bolts, at 3¾ cents per pound; spikes, at 4 cents per pound.

COMMERCIAL STATISTICS FOR LUDINGTON HARBOR, MICHIGAN, CALENDAR YEAR ENDING DECEMBER 31, 1900.

Entrances and clearances.

Calendar year.	Number.	Tonnage.	Calendar year.	Number.	Tonnage.
1888	1,778	277,074	1895	1,556	594,124
1889	1,759	....	1896	1,996	952,469
1890	2,270	461,997	1897	2,063	2,944,425
1891	2,420	610,057	1898	2,498	2,014,019
1892	1,969	538,568	1899	2,587	2,254,495
1893	979	211,438	1900	2,637	2,526,244
1894	1,466	426,599			

Character of vessels.

	Number.	Tonnage.
Steam	2,313	2,495,381
Sail	324	30,863
Total	2,637	2,526,244

Maximum draft, 18 feet.

Receipts and shipments by vessel, 1900.

[Compiled from statement furnished by Wm. Rath, deputy collector of customs at Ludington, Mich.]

Articles received.	Tons.	Articles shipped.	Tons.
Coal	930	Coal	91,501
Iron, ore, etc	14,282	Iron, ore, etc	69,224
Lime and cement	4,634	Lime and cement	1,693
Lumber	187,289	Lumber	57,522
Cedar posts	80	Cedar posts	41
Grain	180,727	Tan bark	21,064
Flour	98,795	Flour	172
Leather	4,277	Leather	3,040
Farm products, miscellaneous	19,626	Farm products, miscellaneous	199
Miscellaneous	83,753	Fruit, miscellaneous	8,141
		Salt	101,402
		Miscellaneous	106,280
Total	594,393	Total	460,279

N N 14.

IMPROVEMENT OF HARBOR AT MANISTEE, MICHIGAN.

The history of this work is carried to July 1, 1900, in the Report of the Chief of Engineers for 1900, page 3919.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1901.

Under contract with William Brownrigg, of Manistee, Mich., in force at the beginning of the fiscal year, the south pier was extended 100 feet by one crib 100 by 30 by 16½ feet, with 6-foot superstructure, and 133 feet of the superstructure of the south pier and 151 feet of that of the north pier have been replaced by new structures 5 feet high. Operations under this contract were concluded upon September 8, 1900. The details of this work are given in the appended extract from the report of Assistant Engineer F. W. Lehnartz:

At the beginning of the fiscal year a contract was in force with William Brownrigg for extending the south pier 100 feet and for renewing the superstructure on portions of the two piers, and part of the work had already been done. The operations under this contract were continued until September 8, when they were completed. The crib placed in extension of the south pier is 100 feet long, 30 feet wide, and 16½ feet deep. It rests on a pile foundation and is completed with a superstructure 6 feet high connecting with the adjacent old work, the whole being filled with stone to the top, and decked over. The outer end is protected by a row of piles driven in contact with the end wall and with three 12 by 12 inch horizontal timbers filling the space between the projecting horns above water. Mooring posts projecting above the deck are built into the superstructure at distances of 50 feet from each other. The top of the new work is 6 feet above zero of gauge. The portions of the piers which were repaired extend from station 6 + 63 to 7 + 96 in the south pier, and from station 18 + 84 to 20 + 35 in the north pier. In both cases the old timbers above the level of zero of gauge were removed and replaced by a new superstructure 5 feet high. The side walls of the substructure needed considerable repairs before the new top timbers could be put on. The repaired structures were refilled with the stone previously removed and decked with 3 by 12 inch planks. The empty corner pockets at the outer end of the north pier were refilled with stone.

CONDITION OF WORKS ON JUNE 30, 1901.

On May 20–24, soundings were made throughout the harbor and river, which showed the following available depths at a stage of —0.8

foot. Outside, 21 feet; at the end of south pier, 18 feet; thence to the inner end of the north revetment, 16 feet, and thence in the river to Manistee Lake, generally not less than 15 feet, except in a short stretch between stations 24 and 35, where the depth was 14.3 feet.

The north pier consists of 1,304 feet of pile work and 1,602 feet of crib work, has a total length of 2,906 feet, and projects 1,265 feet beyond the shore line (see annual report for 1899, page 2940, for statement relating to occupation of part of north revetment at inner end by Manistee and Northeastern Railroad Company. No repairs have yet been made). The crib work between stations 20 + 35 and 22 + 89.5 is 20 to 22 years old and needs new superstructure, and the filling in many pockets of the projecting pier has settled considerably. With these exceptions the pier is in good condition.

The south pier, which is all crib work, is 1,300 feet long and projects 755 feet beyond the shore line. The inner portion of 425 feet is occupied by the Canfield & Wheeler Co., on condition that they maintain it in substantial repair. The part from station 7 + 96 to 8 + 97 is now 22 years old and needs new superstructure, and 100 feet more is 18 to 19 years old and will have to be rebuilt above water before long. With these exceptions the pier is in good condition.

WORK PROPOSED FOR NEXT FISCAL YEAR.

Contract will be entered into for rebuilding above water the part of the north pier between stations 20 + 35 and 22 + 89, and of the south pier between stations 7 + 96 and 8 + 97. This work is now being advertised. Proposals will be opened July 26, 1901, and work is to be completed by December 1, 1901.

ESTIMATE OF FUNDS FOR FISCAL YEAR ENDING JUNE 30, 1901.

To complete the approved project 250 feet of additional crib work in the south pier will be required. This work is necessary and should be done as soon as possible. Based upon the lowest bids received during the past two years for similar work at this and near-by harbors, it is estimated that this extension will cost $33,000, which exceeds the unappropriated balance of the estimate of 1898 by $3,000. Since the completion of the approved project at a cost less than $33,000 is impossible, authority has been received to increase to that amount the estimate for completion of the project, and this accordingly is submitted.

The estimate for maintenance is as follows:

Repairs of 100 linear feet of south pier	$2,000
Refilling piers	2,200
Dredging	6,600
Total for maintenance	10,800

Original estimated cost of the work, 1866, amended in 1871, 1875, 1890, 1892, 1898, and 1901	$428,000.00
Whole amount expended to June 30, 1901	385,824.30

Money statement.

July 1, 1900, balance unexpended		$25,935.15
June 30, 1901, amount expended during fiscal year		16,759.45
July 1, 1901, balance unexpended		9,175.70
July 1, 1901, outstanding liabilities		117.08
July 1, 1901, balance available		9,058.62
July 1, 1901, amount covered by uncompleted contracts		3,000.00
Amount (estimated) required for completion of existing project		33,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901:		
For works of improvement	$33,000.00	
For maintenance of improvement	10,800.00	
		43,800.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

Appropriations for improving harbor at Manistee, Mich.

March 2, 1867	$60,000	August 2, 1882	$15,000
July 11, 1870	20,000	July 5, 1884	10,000
March 3, 1871	9,000	August 5, 1886	10,000
June 10, 1872	10,000	August 11, 1888	10,000
March 3, 1873	10,000	September 19, 1890	50,000
June 23, 1874	10,000	July 13, 1892	50,000
March 3, 1875	25,000	August 18, 1894	12,000
August 14, 1876	14,000	June 3, 1896	15,000
June 18, 1878	15,000	March 3, 1899	20,000
March 3, 1879	10,000		
June 14, 1880	10,000	Total	395,000
March 3, 1881	10,000		

ABSTRACT OF CONTRACTS IN FORCE FOR IMPROVING HARBOR AT MANISTEE, MICH.

Dredging.

Contractor: Green's Dredging Company.
Date of contract: March 24, 1900.
Date of approval: April 12, 1900.
Date of beginning: April 29, 1900.
Date of expiration: September 30, 1900.
Rates: 16½ cents per cubic yard for dredging and $3 per mile for transfer of plant.

Contractor: Samuel O. Dixon.
Date of contract: May 1, 1901.
Date of approval: May 11, 1901.
Date of beginning: May 30, 1901.
Date of expiration: October 15, 1901.
Rate: 18 cents per cubic yard.

Extension and repair of piers.

Contractor: William Brownrigg.
Date of contract: March 10, 1900.
Date of approval: March 22, 1901.
Date of beginning: May 1, 1900.
Date of expiration: December 1, 1900.
Rates: Cutting down old work, at $2.25 per linear foot; dredging, at 99 cents per cubic yard; foundation piles, at 57 cents per linear foot; white-oak round piles, at 43 cents per linear foot; white oak timber, at $45 per 1,000 feet B. M.; white pine timber, at $28 per 1,000 feet B. M.; hemlock timber, at $23.15 per 1,000 feet B. M.; white pine plank, at $22.75 per 1,000 feet B. M.; drift bolts, screw bolts, and spikes, at 4 cents per pound; stone, at $6.85 per cord.

COMMERCIAL STATISTICS FOR MANISTEE HARBOR, MICHIGAN, CALENDAR YEAR ENDING DECEMBER 31, 1900.

Entrances and clearances.

Calendar year.	Number.	Tonnage.	Calendar year.	Number.	Tonnage.
1888	3,595	996,221	1895	3,054	930,645
1889	3,524	945,329	1896	2,355	643,048
1890	3,691	975,049	1897	2,871	666,000
1891	3,617	1,079,818	1898	1,856	528,752
1892	4,044	1,028,629	1899	2,313	698,662
1893	2,831	959,550	1900	2,049	625,630
1894	3,064	956,463			

Character of vessels.

	Number.	Tonnage.
Steam	1,454	522,080
Sail	595	103,550
Total	2,049	625,630

Maximum draft, 14.3 feet.

Receipts and shipments by vessels, 1900.

[Compiled from statement furnished by H. L. Harley, deputy collector of customs at Manistee, Mich.]

Articles received.	Tons.	Articles shipped.	Tons.
Grain	2,407	Lumber	211,582
Feed	12,834	Laths	2,040
Coal	1,300	Shingles	3,962
Flour	5,203	Salt	274,320
Brick	46,441	Bark	12,361
Merchandise, miscellaneous	33,890	Wood and slabs	737
		Potatoes	369
		Merchandise, miscellaneous	18,172
Total	102,075	Total	523,543

N N 15.

HARBOR OF REFUGE AT PORTAGE LAKE, MANISTEE COUNTY, MICHIGAN.

The history of this improvement to the beginning of the year is found in the Report of the Chief of Engineers for 1900, page 3922.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1901.

Dredging under contract with Green's Dredging Company of Chicago, Ill., in progress at the beginning of the fiscal year, was completed. Twelve thousand six hundred and thirty-four cubic yards were removed from July 1 to July 13, thereby creating a through channel 75 feet wide and 13 feet deep. This channel has maintained itself fairly well, the available depth shown by the survey of May 16–18 being 12 feet and the width 60 feet.

Under the contract with Bennett & Schnorbach, of Muskegon, Mich., for pier extension, in force at the beginning of the fiscal year, work has been prosecuted vigorously. The seven cribs required for the completion of the projected length of the north pier have been sunk in place and the superstructure partly finished, and three cribs have been sunk in place in extension of the south pier. For details of work under this contract see the appended extract from the report of Assistant Engineer F. W. Lehnartz:

Contractors Bennett & Schnorbach continued operations for the completion of the pier extension, viz, the addition of 700 feet of crib work to the north pier and of 900 feet of crib work to the south pier. Good progress was made in the prosecution of the work, and at the end of the working season in 1900, when operations were suspended for the winter, the first five cribs, each 100 by 24 by 18½ feet, had been sunk on their pile foundation in prolongation of the north pier, and the two first courses of superstructure and about half of the four remaining courses had been completed, and the whole filled with stone to the top. In addition the construction of the sixth crib for the north pier, 100 by 30 by 18½ feet, and of seventeen courses of the seventh crib for that pier, and of three courses of the first crib for the south pier had been completed. Thirty-six piles already driven for part of the foundation for crib No. 6 were again pulled up to prevent their loss during the winter. Operations were resumed April 9, and since that time the construction of crib No. 7 for the north pier was completed, and both cribs 6 and 7 were sunk in place on a pile foundation, the first on May 11 and the second on May 21, and the two first courses of superstructure were nearly completed to the outer end. Cribs 1, 2, 3, and 4, and seventeen courses of crib No. 5 for the south pier extension, each 100 by 24 by 18½ feet were built, the site of the first three cribs dredged to the required depth, the foundation piles driven and the cribs sunk in their places, No. 1 on June 3, No. 2 on June 17, and No. 3 on June 26.

CONDITION OF WORKS ON JUNE 30, 1901.

The north pier consists of a pile wing 114 feet long at the Portage Lake end, 1,235 feet of pile work along the channel, and 851 feet of crib work. Seven hundred feet of the crib work have been added during the present fiscal year, but the superstructure of this portion is not yet completed. The total length is 2,200 feet, and the pier projects 1,270 feet beyond the shore line. The pier is in good condition.

The south pier consists of 1,399 feet of pile work and 300 feet of crib work, has a total length of 1,699 feet and projects 630 feet beyond the shore line. The wing or return at the east end is 17 feet long in the front wall. Seven hundred and eighty-seven feet of the pile work is in bad shape above water and should be rebuilt and sheet piled before the channel is dredged to the full depth of 18 feet as contemplated by the project. The remainder of the pile work was rebuilt above water and sheet piled in 1897–98, and is in good condition. The crib work was all placed during the present season and is as yet without superstructure. Under the contract now in force this pier will be further extended by 600 feet of crib work.

WORK PROPOSED FOR NEXT FISCAL YEAR.

Contractors Bennett & Schnorbach will continue operations upon their contract for pier extension and will probably complete it before the close of the present working season.

ESTIMATE OF FUNDS FOR FISCAL YEAR ENDING JUNE 30, 1903.

The funds appropriated for the completion of the project by the sundry civil act of June 6, 1900, do not provide for dredging the channel to a depth of 18 feet, as required by the project. Until this depth is secured the harbor will not be available as a harbor of refuge, and no substantial benefits will be realized from the funds thus far provided. An amount of $33,000 for dredging to complete the project was included in the estimate submitted in the last annual report, and this amount is again asked for.

For maintenance an estimate of $5,000 is submitted for dredging and an estimate of $21,600 for repairing 787 linear feet of the south pier.

The harbor is in the collection district of Grand Haven, Mich., which is the nearest port of entry.

Original estimated cost of work, 1879, amended in 1890, 1898, and 1899	$344,300.00
Whole amount expended to June 30, 1901	208,506.76

Money statement.

July 1, 1900, balance unexpended		$157,297.73
June 30, 1901, amount expended during fiscal year		55,304.49
July 1, 1901, balance unexpended		101,993.24
July 1, 1901, outstanding liabilities		290.08
July 1, 1901, balance available		101,703.16
July 1, 1901, amount covered by uncompleted contracts		96,551.64
Amount (estimated) required for completion of existing project		33,800.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901:		
For works of improvement	$33,000.00	
For maintenance of improvement	26,600.00	
		59,600.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

Appropriations for harbor of refuge at Portage Lake, Michigan.

March 3, 1879	$10,000	September 19, 1890	$8,000
June 14, 1880	10,000	August 18, 1894	25,000
March 3, 1881	10,000	June 3, 1896	25,000
August 2, 1882	25,000	March 3, 1899	75,000
July 5, 1884	12,500	June 6, 1900	85,000
August 5, 1886	15,000		
August 11, 1888	10,000	Total	310,500

ABSTRACT OF CONTRACTS IN FORCE FOR HARBOR OF REFUGE AT PORTAGE LAKE, MICHIGAN.

Dredging.

Contractor: Green's Dredging Company.
Date of contract: March 24, 1900.
Date of approval: April 12, 1900.
Date of beginning: April 29, 1900.
Date of expiration: September 30, 1900.
Rates: 16½ cents per cubic yard for dredging and $3 per mile for transfer of plant.

Pier extension.

Contractors: Bennett & Schnorbach.
Date of contract: January 25, 1900.
Date of approval: February 20, 1900.
Date of beginning: May 1, 1900.
Date of expiration: June 30, 1901; extended to December 31, 1901.
Rates: Dredging at 46 cents per cubic yard; foundation piles at 50 cents per linear foot; white-oak guard piles at 35 cents per linear foot; white-oak timber at $45 per

thousand feet, B. M.; white-pine timber at $28 per thousand feet, B. M.; hemlock timber at $22.50 per thousand feet, B. M.; white-pine plank at $25 per thousand feet, B. M.; drift bolts and screw bolts at 3¾ cents per pound; spikes at 4 cents per pound; stone at $6.75 per cord.

COMMERCIAL STATISTICS.

No data relative to the commercial statistics of this harbor can be obtained.

N N 16.

IMPROVEMENT OF FRANKFORT HARBOR, MICHIGAN.

The history of this work is carried to July 1, 1900, in the report of the Chief of Engineers for 1900, page 3925.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1901.

Under contract with Green's Dredging Company the shoal that habitually forms during the winter and encroaches on the channel from the north was removed between July 14 and 19 by the excavation of 3,540 cubic yards of material. The required width of channel was thus restored. Soundings taken May 27–29, at a stage of −0.5 to −0.6 feet, show that this shoal has once more reformed so as to leave a channel of but 80 feet width immediately next to the south pier.

Under contract with Robert Love, of Muskegon, Mich., the north pier has been extended 200 feet by two cribs, each 100 by 24 by 16½ feet, capped by 6-foot superstructure, and 551 feet of the north pier and 101 feet of the south pier have been repaired. Operations under this contract were in progress at the beginning of the fiscal year and were completed November 3, 1900. This work is described in detail in the appended extract from report of Assistant Engineer F. W. Lehnartz:

At the beginning of the fiscal year there was a contract in force with Robert Love for extending the north pier 200 feet, and for repairing the north pier between stations 8 + 44 and 9 + 99 and between stations 0 and 3 + 96, and the south pier between stations 9 + 83 and 10 + 84. Operations under this contract were continued during the working season and completed November 3. The extension of the north pier has consisted in the placing of two cribs, each 100 feet long, 24 feet wide, and 16½ feet deep, on a pile foundation, and completing the same with a superstructure 6 feet high. The work was filled with stone to the top and decked with 3 by 12 inch plank. The space between the outer-end horns is filled with a row of piles close to the end wall and reaching to a penetration of 34 feet below zero of gauge, and with three outer fender or guard timbers between water surface and top of work. Oak mooring posts, projecting above the deck, were built into the work at distances of 50 feet. The repairs of the north pier between stations 8 + 44 and 9 + 99, which is a crib structure 20 feet wide, consisted in cutting the work down to the level of zero of gauge, driving a row of oak piles along the channel face in close contact with the old structure and secured to the same by means of a front oak wale, screw bolts, and tie-rods, and building a new superstructure 5 feet high on top, the front wall resting on the new front piles and the rear wall on the rear wall of the substructure. The work was filled with the old stone previously removed from it and a plank walk 3 feet wide laid on top. The new piles are 4 feet between centers and have a length in the work of 29 to 32 feet. The repairs of the north pier between stations 0 and 3 + 96 were commenced during the previous fiscal year, as described on page 3925, Annual Report of the Chief of Engineers for 1900. They were completed by putting in the remainder of the tie-rods, reaching from the wale on the front piles to the wale on the rear piles, and putting on the new superstructure, which is 5 feet high in the front wall and 3 feet high in the rear wall, except at the extreme easterly end, where both walls are 5 feet high for a length of 11 feet. This part of the structure was refilled with new edgings up to the bottom of the lower cross ties and ballasted with stone 2 feet high. A plank walk 3 feet wide was laid on top. The south pier between stations 9 + 83 and 10 + 84 is a crib work 30 feet wide. The first crib, station 9 + 83 to 10 + 33, has a bad alignment in the pier, projecting about 4 feet into the channel at its westerly end. The repairs consisted in cutting this work down to the level of zero of gauge, repairing the top of the projecting crib, straightening the alignment of the front wall of the pier with piles, and building a new superstructure 6 feet high. The superstructure is about 21 feet wide, the front wall resting on the new front piles or on the projecting part of the substructure and the rear wall on the interior timbers of the substructure. The part of the substructure projecting in the rear of the new superstructure was repaired where needed and decked with 6 by 12 inch timbers. The reconstructed work was filled with the stone previously removed and decked with 3 by 12 inch plank.

CONDITION OF WORKS ON JUNE 30, 1901.

The north pier consists of 396 feet of pile work and 1,304 feet of crib work, has a total length of 1,700 feet, and projects 910 feet beyond the shore line. The pier is generally in good condition except at the extreme east end, where the superstructure has been pushed back about 1 foot by a colliding vessel. The outer 201 feet were added to the pier during the working season of 1900.

The south pier consists of 186 feet of pile work and 1,752 feet of crib work, has a total length of 1,938 feet, and projects 1,540 feet beyond the shore line. The outer section of 400 feet was built by the Toledo and Ann Arbor Railroad Company in 1896–97. One hundred and two feet is twenty-one years old, and 101 feet more is eighteen to nineteen years old, and this entire section, 203 feet in length, needs new superstructure. The superstructure of the pile work and many places in the front wall of the crib work are badly bruised by collision of the car ferries. The filling in many of the crib pockets has settled considerably. With these exceptions the pier is in good condition.

WORK PROPOSED FOR NEXT FISCAL YEAR.

Dredging for the purpose of removing the shoal that narrows the entrance and for widening the channel inside to the extent permitted by available funds will be done under contract with Samuel O. Dixon, when a dredge becomes available for this harbor.

ESTIMATE OF FUNDS FOR FISCAL YEAR ENDING JUNE 30, 1903.

In previous annual reports it has been recommended that the north pier be further extended 400 feet. Recent surveys show that the natural forces affecting the depth at the entrance have attained a state of fairly advantageous equilibrium, and it is doubtful whether it would be desirable to disturb this equilibrium as violently as would be done by extending the north pier 400 feet. It is therefore proposed to extend the north pier 300 feet and the south pier 100 feet, at a total cost of $44,000.

The estimate for maintenance is as follows: For renewing 203 feet superstructure of south pier, $4,020; for refilling cribs of south pier and for minor repairs, $5,500; for dredging, $5,500; total for maintenance, $15,020.

Upon several occasions during the year the piers have been damaged by the car ferry of the Ann Arbor Railroad Company. These injuries have as usual been repaired by the railroad company.

The harbor is in the collection district of Grand Haven, Mich., which is the nearest port of entry.

Original estimated cost of work, 1866, amended in 1868, 1879, 1892, 1898, and 1899	$421,938.35
Whole amount expended to June 30, 1901	374,589.74

Money statement.

July 1, 1900, balance unexpended		$32,233.02
June 30, 1901, amount expended during fiscal year		28,884.41
July 1, 1901, balance unexpended		3,348.61
July 1, 1901, outstanding liabilities		131.00
July 1, 1901, balance available		3,217.61
July 1, 1901, amount covered by uncompleted contracts		1,500.00
Amount (estimated) required for completion of existing project		44,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901:		
For works of improvement	$44,000.00	
For maintenance of improvement	15,020.00	
		59,020.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

Appropriations for improving harbor at Frankfort, Mich.

Aux Becs Scies, Michigan:	
June 23, 1866	$88,541.00
March 2, 1867	10,000.00
July 25, 1868 (allotment)	10,000.00
April 10, 1869 (allotment)	29,318.85
July 11, 1870	10,000.00
March 3, 1871	10,000.00
Frankfort, Mich.:	
June 10, 1872	10,000.00
March 3, 1873	10,000.00
June 23, 1874	10,000.00
March 3, 1875	10,000.00
August 14, 1876	3,000.00
June 18, 1878	8,800.00
March 3, 1879	4,000.00
June 14, 1880	5,000.00
March 3, 1881	10,000.00
Frankfort, Mich.:	
August 2, 1882	$15,000.00
July 5, 1884	5,000.00
August 5, 1886	7,000.00
August 11, 1888	8,000.00
September 19, 1890	10,000.00
July 13, 1892	10,000.00
August 18, 1894	50,000.00
June 3, 1896	15,000.00
March 3, 1899	35,000.00
Total	383,659.85
Amount covered into the Treasury (Report, 1871, p. 133)	5,721.50
	377,938.35

ABSTRACT OF CONTRACTS IN FORCE FOR IMPROVING HARBOR AT FRANKFORT, MICH.

Dredging.

Contractor: Green's Dredging Company.
Date of contract: March 24, 1900.
Date of approval: April 12, 1900.
Date of beginning: April 29, 1900.
Date of expiration: September 30, 1900.
Rates: 16½ cents per cubic yard for dredging, and $3 per mile for transfer of plant.

Contractor: Samuel O. Dixon.
Date of contract: May 1, 1901.
Date of approval: May 11, 1901.
Date of beginning: May 30, 1901.
Date of expiration: October 15, 1901.
Rate: 18 cents per cubic yard.

Extension and repair of piers.

Contractor: Robert Love.
Date of contract: March 23, 1900.
Date of approval: March 31, 1900.
Date of beginning: May 1, 1900.
Date of expiration: December 1, 1900.

Rates: Cutting down old work, at $2 per linear foot; dredging, at 75 cents per cubic yard; foundation piles, at 50 cents per linear foot; white-oak round piles, at 40 cents per linear foot; white-oak timber, at $45 per M feet B. M.; white-pine timber, at $28 per M feet B. M.; hemlock timber, at $23 per M feet B. M.; white-pine plank, at $24 per M feet B. M.; drift bolts, screw bolts, tie-rods, and spikes, at 4 cents per pound; stone, at $6.75 per cord; edgings, at $3 per cord.

COMMERCIAL STATISTICS FOR FRANKFORT HARBOR, MICHIGAN, CALENDAR YEAR ENDING DECEMBER 31, 1900.

Entrances and clearances.

Calendar year.	Number.	Tonnage.	Calendar year.	Number.	Tonnage.
1888	1,342	216,376	1895	1,182	412,951
1889 *a*			1896	1,374	509,277
1890	443	57,140	1897	1,714	706,546
1891	1,541	258,908	1898	1,681	793,896
1892	910	167,777	1899	1,790	1,405,955
1893	988	278,709	1900	1,480	1,308,722
1894	1,101	337,728			

a No report.

Character of vessels.

	Number.	Tonnage.
Steam	1,270	1,278,474
Sail	210	30,248
Total	1,480	1,308,722

Maximum draft, 18 feet.

Receipts and shipments by vessel, 1900.

[Compiled from statement furnished by the deputy collector of customs at Frankfort, Mich.]

Articles received.	Tons.	Articles shipped.	Tons.
Bran, etc	17	Lumber	33,110
Hay, etc	142	Shingles	140
Freight cars, loaded	260,520	Ties, posts, bark, etc	18,157
Freight cars, empty	5,696	Fruit	63
		Potatoes	46
Total	266,375	Freight cars, loaded	237,640
		Freight cars, empty	17,760
		Total	306,916

N N 17.

IMPROVEMENT OF HARBOR AT CHARLEVOIX, MICHIGAN.

The history of the improvement is carried to July 1, 1900, in the report of the Chief of Engineers for 1900, page 3928.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1901.

Operations under the contract with Green & Anderson, of Green Bay, Wis., which were in progress at the beginning of the fiscal year, were completed August 24. This work has resulted in the repair of 402 feet of the south pier, and is fully described in the following extract from the report of Assistant Engineer F. W. Lehnartz:

> The operations under the contract with Green & Anderson for the repair of the south pier between stations 11+25 and 15+27, which were in progress at the beginning of the fiscal year, were completed August 24. The repairs have consisted in cutting down or removing the part of the old structure above the level of zero of gauge and the front wall of the crib substructure between stations 14+87 and 15+27, in driving new rows of oak front piles and rear piles, connecting the rows by means of front and rear wales and tie rods, and building a new superstructure on top, 5 feet high in the front wall and 4 feet high in the rear wall, with cross-ties 8 feet from center to center. The new front piles are 30 feet long in the work, with the top at the level of zero of gauge, and average 3 feet between centers from stations 11+25 to 14+28, 4 feet between centers from stations 14+28 to 14+84, and 2 feet between centers from stations 15+84 to 15+25. The still serviceable old piles remaining in the pier have been retained and have been connected with the new structure by means of drift and screw bolts. The piles in the rear row are 20 feet long in the work and are driven 8 feet from center to center. A plank wall 3 feet wide was laid on the superstructure. No filling was placed in the work, beyond that already in place, and it is probable that provision will have to be made for this in the future, for the protection of the channel.

CONDITION OF WORKS JUNE 30, 1901.

Lower channel, Lake Michigan to Round Lake.—The north pier consists of 303 feet of crib work, 477 feet of stone pier, and 945 feet of plank beam revetment, has a total length of 1,725 feet, and projects 755 feet beyond the shore line. The crib work is 21 to 22 years old, and needs rebuilding above water. The stone pier has been somewhat damaged at its westerly end, and needs an extension of about 25 feet at its east end to connect it with the shore. The plank beam is a total wreck for nearly its entire length. The inner end of this revetment is occupied by private parties as a shipping dock. The south pier consists of 491 feet of crib work and 1,539 feet of pile work, has a total length of 2,030 feet, and projects 365 feet beyond the shore line. Forty feet of the crib work and 362 feet of the pile work were repaired during the working season of 1900. Fifty linear feet of the pile work at the inner end is occupied by private parties as a steamboat dock. Two hundred and fifty-one feet of the crib work is 22 to 23 years old, and needs new superstructure, and the crib at the outer end has lost considerable of its ballast. The remainder of the pier is in good condition.

Upper channel, Round Lake to Pine Lake.—The north revetment is 339 feet long, and the south revetment is 366 feet long. Both revetments are pile structures. The north revetment is a total wreck above water on account of fires and decay. The south revetment is in better condition, although it is badly decayed above water.

No dredging has been done during the fiscal year. Soundings made May 31–June 3, show available depth of 16 feet outside, 15.8 feet in a narrow channel between the piers of the lower channel and 13.5 feet between the revetments of the upper channel, at the existing stage of −0.7 feet.

WORK PROPOSED FOR NEXT FISCAL YEAR.

Under contract with Samuel O. Dixon, of Milwaukee, Wis., the required width and depth of channels are to be restored so far as permitted by available funds. This work is to be begun as soon as one of the three dredges employed under the contract becomes available.

ESTIMATE OF FUNDS FOR FISCAL YEAR ENDING JUNE 30, 1903.

The approved project provides for an extension of 200 feet to the south pier, at an estimated cost of $19,800.

The estimate for maintenance is as follows:

Repairs to north pier and revetment (lower channel)	$20,500
Repairs to south pier	3,325
Repairs to north revetment of upper channel	3,000
Dredging	4,400
Total for maintenance	31,225

The harbor is in the collection district of Grand Haven, Mich., which is the nearest port of entry.

Original estimated cost of work, 1868, amended in 1876 and 1884	$186,000.00
Whole amount expended to June 30, 1901	151,112.58

Money statement.

July 1, 1900, balance unexpended		$12,327.44
June 30, 1901, amount expended during fiscal year		7,940.02
July 1, 1901, balance unexpended		4,387.42
July 1, 1901, amount covered by uncompleted contracts		2,000.00
Amount (estimated) required for completion of existing project		30,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901:		
For works of improvement	$19,800.00	
For maintenance of improvement	31,225.00	
		51,025.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

Appropriations for improving harbor at Charlevoix, Mich.

August 14, 1876	$10,000
June 18, 1878	12,000
March 3, 1879	9,000
June 14, 1880	10,000
March 3, 1881	10,000
August 2, 1882	10,000
July 5, 1884	10,000
August 5, 1886	10,000
August 11, 1888	$12,500
September 19, 1890	9,000
July 13, 1892	10,000
August 18, 1894	8,000
June 3, 1896	20,000
March 3, 1899	15,000
Total	155,500

ABSTRACT OF CONTRACTS IN FORCE FOR IMPROVING HARBOR AT CHARLEVOIX, MICH.

Dredging.

Contractor: Green's Dredging Company.
Date of contract: March 24, 1900.
Date of approval: April 12, 1900.
Date of beginning: April 29, 1900.
Date of expiration: September 30, 1900.
Rates: 16½ cents per cubic yard, and $3 per mile for transfer of plant.

Contractor: Samuel O. Dixon.
Date of contract: May 1, 1901.
Date of approval: May 11, 1901.
Date of beginning: May 30, 1901.
Date of expiration: October 15, 1901.
Rate: 18 cents per cubic yard.

Repair of pier.

Contractors: Green & Anderson.
Date of contract: April 27, 1900.
Date of approval: May 7, 1900.
Date of beginning: June 8, 1900.
Date of expiration: December 1, 1900.
Rates: Cutting down old work, at $2 per linear foot; white-oak round piles, at 45 cents per linear foot; white-oak timber, at $55 per M feet B. M.; white-pine timber, at $32 per M feet B. M.; white-pine plank, at $26 per M feet B. M.; drift bolts, screw bolts, and tie rods, at 4½ cents per pound; spikes, at 4 cents per pound.

COMMERCIAL STATISTICS FOR CHARLEVOIX HARBOR, MICH., CALENDAR YEAR ENDING DECEMBER 31, 1900.

Entrances and clearances.

Calendar year.	Number.	Tonnage.	Calendar year.	Number.	Tonnage.
1888	526	92,306	1895	528	92,387
1889	473	....	1896	420	75,263
1890	582	75,224	1897	545	110,474
1891	534	79,618	1898	566	106,797
1892	537	79,966	1899	675	144,100
1893	820	144,976	1900	1,725	350,769
1894	1,701	388,015			

Character of vessels.

	Number.	Tonnage.
Steam	387	88,752
Sail	1,338	262,017
Total	1,725	350,769

Maximum draft, 13.5 feet.

Receipts and shipments by vessels, 1900.

[Compiled from statement furnished by W. A. Smith, deputy collector of customs at Charlevoix, Mich.]

Articles received.	Tons.	Articles shipped.	Tons.
Coal	23,988	Lumber	152,630
Grain	5,712	Posts	2,993
Oil	285	Ties	17,240
Salt	476	Bark	16,042
Feed	4,879	Shingles	2,070
Merchandise, miscellaneous	4,800	Slabs	21,284
		Wood	6,612
Total	39,640	Flour	250
		Apples	60
		Merchandise, miscellaneous	2,000
		Total	221,181

N N 18.

IMPROVEMENT OF HARBOR AT PETOSKEY, MICHIGAN.

For history of this improvement to July 1, 1900, see Report of the Chief of Engineers for 1900, page 3932.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1901.

Under contract with Adolph Green, of Green Bay, Wis., dated August 6, 1900, the base of the stone foundation of the north breakwater was made wider and stronger by placing 181.5 cords of riprap along the front of the north and end walls, and the inshore section of the west breakwater, which had been breached, was restored to its original cross section by the use of 37.5 cords of stone. All the stone weighed not less than 2,000 pounds. Operations began August 27 and ended September 20, 1900.

CONDITION OF WORKS JUNE 30, 1901.

The north breakwater consists of 200 linear feet of crib work, and the west breakwater of 401 feet of crib work with an inshore section 200 feet long built of stone. The works are generally in good condition, but the upper nine courses of the west wall of the west breakwater, the northeast horn of the west breakwater, and the southeast horn of the north breakwater above water are broken by blows from colliding vessels.

ESTIMATE OF FUNDS FOR FISCAL YEAR ENDING JUNE 30, 1903.

The balance of the available funds is applicable to the extension of the north breakwater required by the approved project. The amount asked for is the estimated amount, in addition to the available balance, necessary for that extension. No dredging is required at this harbor.

The harbor is in the collection district of Grand Haven, Mich., which is the nearest port of entry.

Original estimated cost of work	$170,000.00
Whole amount expended to June 30, 1901	55,260.37

Money statement.

July 1, 1900, balance unexpended	$20,970.79
November 9, 1900, deposited—account disallowance	2.86
	20,973.65
June 30, 1901, amount expended during fiscal year	3,234.02
July 1, 1901, balance unexpended	17,739.63
Amount (estimated) required for completion of existing project	97,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	66,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

Appropriations for improving harbor at Petoskey, Mich.

September 19, 1890	$15,000
July 13, 1892	20,000
August 18, 1894	10,000
June 3, 1896	8,000
March 3, 1899	20,000
Total	73,000

ABSTRACT OF CONTRACTS IN FORCE FOR IMPROVING HARBOR AT PETOSKEY, MICH.

Repair of breakwaters.

Contractor: Adolph Green.
Date of contract: August 6, 1900.
Date of approval: August 29, 1900.
Date of beginning: October 4, 1900.
Date of expiration: October 1, 1900.
Rate: Stone at $12 per cord.

COMMERCIAL STATISTICS.

Entrances and clearances.

Calendar year.	Number.	Tonnage.	Calendar year.	Number.	Tonnage.
1893	1,338	8,000	1897	4,362	91,600
1894	4,160	20,000	1898	4,704	76,000
1895	4,860	28,000	1899		
1896	3,156	24,000	1900		

No data relative to the commercial statistics for calendar years 1899 and 1900 could be obtained.

N N 19.

PRELIMINARY EXAMINATION OF MUSKEGON HARBOR, MICHIGAN, WITH A VIEW TO OBTAINING A CHANNEL OF THE DEPTH OF 20 FEET AND A UNIFORM WIDTH OF 300 FEET FROM THE EXTERIOR TO THE INTERIOR LAKE; THE PLAN TO PROVIDE FOR SHEET PILING TO PREVENT EROSION ALONG THE BANKS NOT PROTECTED BY CRIBS.

[Printed in House Doc. No. 104, Fifty-sixth Congress, second session.]

Office of the Chief of Engineers,
United States Army,
Washington, November 28, 1900.

Sir: I have the honor to submit herewith copy of report dated August 6, 1900, with map,[1] by Capt. Chester Harding, Corps of Engineers, upon preliminary examination of Muskegon Harbor, Michigan, with a view to obtaining a channel of the depth of 20 feet and a uniform width of 300 feet from the exterior to the interior lake, the plan to provide for sheet piling to prevent erosion along the banks not protected by cribs, made in accordance with requirements of the emergency river and harbor act of June 6, 1900.

This harbor is now being improved under a project contemplating the maintenance of a channel of 15 feet depth, and Captain Harding presents a plan for further improvement by dredging, pier extension, revetment, etc., at an estimated cost of $380,000. He states that there is no question in his mind of the desirability of enlarging the scope of the existing project for this harbor, and his views are concurred in by the Division Engineer, Col. J. W. Barlow, Corps of Engineers.

The estimates assume that the land to be removed in order to secure the increased width of channel and to build the revetments will be ceded without cost to the United States; also that an area equal to that at present occupied by the United States Life-Saving Service will be restored to the United States for the same occupation and purpose.

Very respectfully, your obedient servant,

John M. Wilson,
Brig. Gen., Chief of Engineers,
U. S. Army.

Hon. Elihu Root,
Secretary of War.

REPORT OF CAPT. CHESTER HARDING, CORPS OF ENGINEERS.

United States Engineer Office,
Grand Rapids, Mich., August 6, 1900.

General: I have the honor to submit the following report of a preliminary examination of Muskegon Harbor, Michigan, made to determine the advisability of its improvement by the United States in accordance with the following project: To obtain "a channel of the depth of 20 feet and a uniform width of 300 feet from the exterior to the interior lake; the plan to provide for sheet piling to prevent erosion along the banks not protected by cribs." The examination and report were required by section 2 of the act of Congress approved June 6, 1900, making provisions for emergencies in river and harbor work and certain surveys.

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[1] Not reprinted; printed in House Doc. No. 104, Fifty-sixth Congress, second session.

Muskegon Harbor has been under improvement by the United States since 1867, the object being to provide a practicable entrance into Muskegon Lake from Lake Michigan. The present condition of the improvement and the extent of the harbor structures built and maintained by the Government are shown on the accompanying map. The existing project, adopted in 1892, provides for the maintenance of a channel of a depth of 15 feet, and as a means to that end, extensions of 350 feet to the north pier and 200 feet to the south pier, in addition to the extensions of 200 and 100 feet to the north and south piers, respectively, now in process of construction. An inspection of the map indicates two unfavorable features of the harbor: One is the absence of revetments along a considerable extent of the banks of the channel, and the other is the funnel-shaped entrance. The first has not thus far added materially to the expense of maintaining a practicable through channel of 15 feet depth; but if a considerable increase of depth is to be secured, sand-tight revetments should unquestionably form a part of the plans. The second feature, which resulted from the necessity of securing a wider entrance to the harbor, is a source of difficulty and danger during westerly storms, as the seas increase in size and force as they enter the contracted portion of the channel. I regard the correction of these two unfavorable conditions as a desirable part of any project looking to the creation at this point of a safe and satisfactory harbor with depths accommodating vessels of a draft of 16 feet or more.

There is no question in my mind of the desirability of enlarging the scope of the existing project for this harbor. In point of population and extent of commercial interests Muskegon is the principal city on the east shore of Lake Michigan. Muskegon Lake, on which the city is located, is a body of water of depths ample for all lake craft, and of considerable extent, being about 5 miles long, east and west, and about 2½ miles wide at its widest part. It furnishes an excellent interior harbor, and if safely accessible from Lake Michigan would constitute a valuable harbor of refuge. There are two lines of daily steamers from Muskegon to Chicago, and one from Muskegon to Milwaukee, the latter operating throughout the entire year. Muskegon is the terminus of three railway lines, one of which has established a car ferry to Milwaukee. The commercial statistics furnished by the local chamber of commerce indicate that the number of entrances and clearances during the calendar year 1899 were 2,247, representing a total registered tonnage of 2,081,067. The receipts and shipments by vessel during the same year aggregate 833,963 tons. The principal manufacturing industries located in Muskegon, with their capitalization, extent of business, and number of employees, are shown in the attached table furnished me by the local chamber of commerce.

Since the adoption of the present project, in 1892, there has developed a well-recognized tendency to increased draft in vessels navigating the Great Lakes, and in the case of five other harbors in this district this tendency has been met by modifications of projects to provide for depths of 18 feet. A similar enlargement of the Muskegon project is, in my judgment, fully warranted by the amount and extent of the commercial interests involved. The estimated cost of securing a channel 20 feet deep and 300 feet wide, according to the plans outlined on the accompanying tracing, is as follows:

Dredging 750,000 cubic yards, at 10 cents per yard	$75,000
Removing the old pier and revetment, 1,040 feet, at $25 per foot	26,000
500 feet of sheet-pile pier, at $50 per foot	25,000
6,115 feet of sheet-pile revetment, at $25 per foot	152,875
550 feet of pier extensions, at $120 per foot[1]	66,000
Contingencies	35,125
Total	380,000

The above estimates assume that the land to be removed in order to secure the increased width of channel and to build the revetments will be ceded without cost to the United States; also that an area equal to that at present occupied by the United States Life-Saving Service will be restored to the United States for the same occupation and purpose. The estimates for a channel of the same width, and depth of 18 feet, would differ from the above only in the item of dredging, the estimated difference being about $10,000. Although it is my opinion that a channel 18 feet deep will satisfy the needs of this harbor for many years, the slight increase in cost for securing a depth of 20 feet suggests the expediency of adopting the greater depth in the project. No further survey is required, as the data available from the previous improvement of the locality have been sufficient for making detailed plans and estimates.

Very respectfully, your obedient servant,

CHESTER HARDING,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, NORTHWEST DIVISION,
New York, August 9, 1900.

Respectfully forwarded to the Chief of Engineers, U. S. A.

Muskegon Harbor is one of the most important harbors on the east shore of Lake Michigan.

A deep and practicable entrance into Muskegon Lake would provide an excellent harbor of refuge, in addition to improving the present inadequate facilities for local commerce.

The project to extend the piers and rebuild the revetment, as shown on accompanying map, is recommended for approval.

J. W. BARLOW,
Colonel, Corps of Engineers,
Division Engineer.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
October 29, 1900.

Respectfully submitted to the Secretary of War.

The emergency river and harbor act approved June 6, 1900, provided for a preliminary examination of Muskegon Harbor, Michigan, and, under certain favorable conditions, a survey was to be made upon authority of the Secretary of War, at his discretion, and plan and estimate of cost was to be prepared.

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[1] The pier extensions estimated for are contemplated in the present approved project.

Under a misapprehension of the law the local officer included in the within report of the preliminary examination a plan and estimate of cost of improvement deemed advisable at Muskegon, and I recommend that his action in combining in one report the substance of the two contemplated by the act be approved.

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

[Third indorsement.]

WAR DEPARTMENT,
November 3, 1900.

Approved as recommended by the Chief of Engineers.
By order of the Secretary of War:

JOHN C. SCOFIELD,
Chief Clerk.

Statement giving the principal manufacturing industries located in Muskegon, with their capitalization, extent of business, and number of employees.

No.	Nature of business.	Capital employed.	Amount of business, 1899.	Number of employees.
1	Iron, steel, and tin plate	$400,000	$900,000	600
2	Manufacturers of paper[a]	350,000	....	150
3	Manufacturers of pianos	220,000	150,000	77
4	Tannery	100,000	160,000	50
5	Interior finish, sash, doors, etc	75,000	68,000	64
6	Manufacturers of beer	150,000	168,000	35
7	Nail kegs	65,000	200,000	82
8	Knitted and leather goods	45,000	30,000	48
9	General woodworking	30,000	6,000	6
10	Shade rollers[b]	1,000,000	400,000	240
11	Knitting works	15,000	20,000	99
12	Boiler works	50,000	85,000	60
13	Machinery and repairs	15,000	16,000	22
14	Knitting works	200,000	519,207	1,030
15	Lumber	500,000	700,000	220
16	.....do	80,000	125,000	75
17	Machinery and repairs	80,000	97,000	85
18	Office furniture	50,000	138,000	120
19	Interior work, sash, doors, boxes	85,000	112,000	85
20	Lumber	80,000	124,000	45
21	Furniture specialties	110,000	80,000	60
22	Furniture	140,000	150,000	175
23	Boxes, planing mill, general woodwork	20,000	65,000	125
24	Malleable iron	100,000	200,000	275
25	Brass works	2,700	10,000	6
26	Iron foundry	100,000	48,000	45
27	Special iron-working machinery	90,000	78,000	65
28	Office furniture	147,000	175,000	240
29	Washing machines	20,000	75,000	40
30	Refrigerators	200,000	275,000	310
31	Office and special furniture	40,000	50,000	95
32	Electric cranes	138,660	526,000	240
33	Chemical fire engine and brass works	40,000	45,000	40
34	Gas	65,000	30,000	15
35	Electric light	65,000	30,000	20
36	Electric street railway	220,000	51,000	50
37	Lumber	75,000	125,000	25
38	Repair shops, cars, etc.[c]	....	....	232
39	Sawmill	20,000	10,000	29
40	Flour, etc	55,000	250,000	22
41	Lime	10,000	25,000	6
42	Office furniture and specialties	20,000	40,000	42
43	Furniture specialties	12,500	65,000	50
44	Interior woodwork	3,000	10,000	10
45	Saw manufacturers	20,000	25,000	9
46	Lumber	400,000	150,000	101
47	Plumbing, etc	40,000	50,000	25
48	45 celery growers	150,000	100,000	300
	Total	5,888,860	6,756,207	5,845

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[a] Just started business.
[b] Branch woodworking department; main office, East Newark, N. J.
[c] Amount of investment and business done not ascertained.

APPENDIX O O.

IMPROVEMENT OF RIVERS AND HARBORS ON THE EASTERN COAST OF MICHIGAN, NORTH OF LAKE ERIE.

REPORT OF MAJ. W. L. FISK, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1901, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Cheboygan Harbor, Michigan.
2. Alpena Harbor (Thunder Bay River), Michigan.
3. Saginaw River, Michigan.
4. Sebewaing River, Michigan.
5. Harbor of refuge at Sandbeach, Lake Huron, Michigan.
6. Mouth of Black River, Michigan.
7. Black River at Port Huron, Michigan.
8. Pine River, Michigan.
9. Belle River, Michigan.
10. Clinton River, Michigan.
11. Rouge River, Michigan.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., July 18, 1901.

GENERAL: I have the honor to transmit herewith the annual reports for the works of river and harbor improvement in my charge for the fiscal year ending June 30, 1901.

Very respectfully, your obedient servant,

W. L. FISK,
Major, Corps of Engineers.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

O O 1.

IMPROVEMENT OF CHEBOYGAN HARBOR, MICHIGAN.

The present project of improvement, adopted by the river and harbor act of June 3, 1896, calls for a channel 200 feet wide with a navigable depth of 18 feet from deep water in the Straits of Mackinac to the State Road Bridge over the Cheboygan River. Improvements date back to 1871, when the available channel depth was only 6 feet, but the result of work done to date is a straight channel 200 feet wide with a navigable depth of 18 feet through about three-fourths of its length and with depths varying from 10 to 14 feet through the remaining distance to the upper limit of the harbor. The report of the Chief of Engineers for 1896 (pp. 2723, 2724) summarizes the history of operations to that time, and no further work of improvement was done until the summer of 1898. The total length of improved channel from deep water in the straits to the State Road Bridge is 7,900 feet, or 1½ miles.

At the beginning of the fiscal year 1900 the available channel depth was generally 15 feet, but dredging done during that year provided the harbor with a channel 200 feet wide and a navigable depth of 18 feet from the deep-water channel in the Straits of Mackinac to a point about 2,700 feet below the upper limit of the harbor. The resultant benefit to commerce is that vessels may load 3 feet deeper and reach the principal harbor landings with that increased draft.

While the work of improvement was in progress the harbor was resurveyed, as required by the river and harbor act of March 3, 1899, with a view to estimating the cost of completing the channel to a navigable depth of 18 feet throughout the harbor limits. Lieut. Col. (now Col.) G. J. Lydecker submitted a special report of this survey, with map, under date of April 14, 1900, and the report will be found at page 4012, Annual Report of Chief of Engineers for 1900.

From data supplied by the survey above referred to it was estimated that the cost of completing the improvement as proposed, and as the present approved project requires, will be $15,500. Considerable hard material (bowlders and hardpan) will be met with in that part of the harbor which remains to be improved, and the unit price for dredging will be considerably greater than that at which work was done in the lower section. If the improvement is to be finished with due regard to economy of expenditure or timely completion, the full amount of money required should be appropriated by the next river and harbor act.

Cheboygan is in the Michigan collection district and the nearest port of entry is Grand Haven, Mich. The nearest light-house is on the crib at entrance to the harbor.

Original estimated cost of dredging and pier construction, 1871	$395,000.00
Whole amount expended to June 30, 1901	165,563.86

Money statement.

July 1, 1900, balance unexpended	$2,719.14
June 30, 1901, amount expended during fiscal year	283.00
July 1, 1901, balance unexpended	2,436.14
July 1, 1901, outstanding liabilities	13.18
July 1, 1901, balance available	2,422.96
Amount (estimated) required for completion of existing project	15,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	15,500.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

Appropriations for improving harbor at Cheboygan, Mich.

March 3, 1871	$10,000	March 3, 1881	$6,000
June 10, 1872	15,000	August 2, 1882	10,000
March 3, 1873	15,000	July 5, 1884	5,000
June 23, 1874	15,000	August 5, 1886	15,000
March 3, 1875	15,000	August 11, 1888	15,000
August 14, 1876	10,000	June 3, 1896	12,000
June 18, 1878	8,000	March 3, 1899	8,000
March 3, 1879	3,000		
June 14, 1880	6,000	Total	168,000

COMMERCIAL STATISTICS, CHEBOYGAN HARBOR, MICHIGAN, FOR CALENDAR YEAR ENDING DECEMBER 31, 1900.

Entrances and clearances.

Calendar year.	Number.	Tonnage.	Calendar year.	Number.	Tonnage.
1887	1,587	405,921	1894	1,350	379,845
1888	(*a*)	(*a*)	1895	1,211	378,291
1889	1,496	453,456	1896	1,233	379,069
1890	(*a*)	(*a*)	1897	1,216	386,559
1891	1,384	367,550	1898	1,336	422,741
1892	1,384	345,174	1899	1,368	415,613
1893	1,240	308,129	1900	1,520	504,069

a Not stated.

Receipts and shipments by vessel.

[Compiled from statement furnished by Mr. C. L. Marquette, deputy collector of customs, Cheboygan, Mich.]

Articles.	Received.	Shipped.
	Tons.	*Tons.*
Brick	250	
Coal, bituminous	4,284	
Flour	750	1,240
Grain	1,663	8
Hay and feed	75	
Iron and ore	129	20
Live stock	10	3
Logs	18,750	47,500
Merchandise, general	16,823	2,292
Furniture	100	
Mill stuff	540	
Barrels	4	
Oil	17	
Coal, anthracite	667	
Posts	175	8,473
Total	44,237	59,536

Vessels trading to port.

Description.	Number.	Tonnage.
Steamers	1,155	414,152
Schooners	365	89,917

O O 2.

IMPROVEMENT OF ALPENA HARBOR (THUNDER BAY RIVER), MICHIGAN.

The object of the present project of improvement is to provide and maintain a navigable channel depth of 16 feet from Thunder Bay to and through that portion of Thunder Bay River which passes through the city of Alpena. The original depth of entrance to the river was only 7 feet, but local enterprise had increased this to 12 feet, through a narrow channel, before work was commenced by the Government in 1876. The improvements carried on since that time have given greater width of channel and increased its depth to 13, 14, and 16 feet under three successive projects, work under the last one having been completed in 1893. A summary of operations to June 30, 1896, is published in the report of the Chief Engineers for that year (pp. 2725, 2726), and subsequent operations to June 30, 1899, were limited to such supervision and examinations as were required for protecting the interests of navigation and securing reliable information concerning the navigable condition of the harbor.

Shortly before the beginning of the fiscal year 1900 it was found that the channel had shoaled to a depth of from 12 to 13 feet and that navigation was thereby obstructed to such an extent as to make it necessary to redredge the harbor from near the steamboat docks at its upper limit to deep water in Thunder Bay. Contract was accordingly entered into August 8, 1899, for further dredging. Work was commenced September 5 and completed November 8, the total amount of excavation being 42,497 cubic yards, and its cost, at 13½ cents per cubic yard, scow measure, $5,737.09, excluding expenses of supervision, engineering, and office contingencies. The dredged material was mainly sand, clay, and mill refuse, but some harder material, including embedded cobblestones and a few small bowlders, was unexpectedly encountered in the bay section of channel. The result of the work was to provide the harbor and its outlying channel of approach with a navigable depth of 16 feet. The resultant benefit to commerce is that vessels may now load 3 feet deeper than before and pass to or from all docks in the harbor with that increased draft.

Past experience justifies the expectation that the improved channel will deteriorate very slowly and that no expenditure for maintenance or restoration is likely to be needed in the near future. For this reason it is not considered necessary to submit any estimate for further appropriation at present.

Alpena is in the collection district of Huron, Mich., and the nearest port of entry is Port Huron, Mich. The nearest light-house is at the entrance to the harbor.

Original estimate of cost, 1876, 1881, and 1889 (aggregate)	$55,851.48
Whole amount expended to June 30, 1901	49,174.07

Money statement.

July 1, 1900, balance unexpended	$2,685.93
June 30, 1901, amount expended during fiscal year	360.00
July 1, 1901, balance unexpended	2,325.93

Appropriations for improving harbor at Alpena (Thunder Bay River), Mich.

Thunder Bay Harbor, Michigan:	
August 14, 1876	$4,500
August 2, 1882	15,000
September 19, 1890	5,500
Thunder Bay River, Michigan:	
September 19, 1890	10,000
July 13, 1892	10,000
Alpena Harbor, Michigan:	
August 18, 1894	4,000
June 3, 1896	2,500
Total	51,500

COMMERCIAL STATISTICS OF ALPENA HARBOR (THUNDER BAY RIVER), MICHIGAN, FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1900.

Entrances and clearances.

Calendar year.	Number.	Tonnage.	Calendar year.	Number.	Tonnage.
1893	940	247,278	1897	1,245	353,982
1894	1,033	303,681	1898	980	270,743
1895	1,249	325,899	1899	802	221,888
1896	1,040	272,921	1900	1,976	478,875

Vessels trading to port.

Description.	Number.	Tonnage.
Steamers	25	4,800
Steam barges	30	8,975
Barges, schooners, scows, sloops	68	15,373

Receipts and shipments by vessel.

[Compiled from statement furnished by Mr. James S. Moffat, deputy collector of customs, Alpena, Mich.]

Articles.	Received.	Shipped.
	Tons.	*Tons.*
Brick	30	
Cedar posts		10,653
Farm products, miscellaneous	24	
Fish		55
Flour	800	
Fruit, miscellaneous	300	
Grain	1,823¼	
Hay and feed	800	
Lath		3,126
Lime and cement	11	
Live stock	17½	
Lumber		92,012
Machinery	25,000	75,000
Merchandise, general	600	50
Paper	50	100
Salt	1,722	
Shingles		861
Telegraph poles		319
Unclassified freight	20,475	8,390
Cedar ties		73,136
Total	51,653	263,702

O O 3.

IMPROVEMENT OF SAGINAW RIVER, MICHIGAN.

The improvement of this river, including the bar at its mouth in Saginaw Bay, was commenced in 1867, but it was not until 1882 that the present project was adopted, the object of which is to provide a through channel from deep water in the bay to the city of Saginaw. The uniform width of the improved channel called for by the project is 200 feet, and the navigable depth to be obtained to the upper limits of Bay City is 14 feet, and from there to Saginaw 12 feet. The report of the Chief of Engineers for 1896 (pp. 2727, 2728) summarizes the history of operations to June 30 of that year, and, with the exception of completing a little dredging under a contract then in force, no further work was done until the summer of 1899.

An examination of the river and bar at its mouth was made in the spring of 1899, which showed that the general depth of water in the channel through the bar had become reduced to 13 feet and that the general depth of all improved channels above Bay City was but 10 feet, while that through the Bristol Street shoal at Saginaw was only 8 feet. It was therefore necessary to provide for redredging these impaired channels, and, with that object in view, an advertisement was published June 30, 1899, inviting proposals for the work. Bids were opened July 24 and contracts duly awarded to the lowest bidders, as follows: For bar at mouth of Saginaw River, Michigan, to G. H. Breymann & Bros., of Toledo, Ohio, and for Saginaw River, Michigan, to the Bay City Dredging Company, of Bay City, Mich.

Operations under the above contracts were prosecuted during the fiscal year 1900 as follows:

Work under the contract with G. H. Breymann & Bros. was commenced August 23 and suspended for the winter December 5, 1899; it was resumed May 15, 1900, and was still in progress at the close of that fiscal year. From that date to the completion of the contract, on July 24, 1900, 23,705 cubic yards were excavated, making the total under the contract 125,355 yards.

The result of this work is that a channel of 16 feet in depth has been completed across the bar at the mouth of the river to the full width of 200 feet, except about 4,500 feet on the easterly half of the shore end of the dredged channel. To complete this portion to the full width will require the removal of about 30,000 cubic yards.

Work under the contract with the Bay City Dredging Company was commenced August 23 and suspended for the winter December 5, 1899. It was resumed May 2, 1900, and was still in progress at the close of that year. The total excavation to June 30, 1900, was 86,811 cubic yards.

The time limit for completing work under this contract was June 30 1900, but the contractor did not meet this requirement because of his failure to carry on operations with sufficient plant or energy during a portion of the time that work was in progress. Additional time was therefore allowed him, subject to deduction for costs of supervision during the period of extension, and the work was completed August 27, 1900. From July 1 to date of completion 38,831 cubic yards were dredged, or a total under the contract of 125,642 cubic yards, restoring the depth of the 14 and 12 foot channels, but only for one-half the projected width.

In relation to future operations, the following views, in substance, were presented by Lieut. Col. (now Col.) G. J. Lydecker in his annual report for 1899, and they are equally applicable now:

> The present approved project of improvement can not be realized by operations on such a restricted scale as the limited appropriations of recent years have necessitated. The practical result of these operations has been only an uncertain and unsatisfactory maintenance of the series of unfinished channels which were obtained by the work done under the appropriation of $125,000 made by the river and harbor act of August 2, 1882, shortly after the project was adopted. Nevertheless, the river and harbor act of June 3, 1896, called for an estimate of the cost of providing channels 2 feet deeper and extending the improvement 2½ miles still farther upstream than the project of 1882 contemplates. The estimate was duly submitted (see Annual Report Chief of Engineers for 1898, pp. 2600–2603), but no action was taken on it by Congress, and from the small appropriation that followed it is to be inferred that the older project and methods of operation are to remain unchanged, for the present at

least. I therefore submit below an estimate of $50,000 as the amount that will probably be required for maintaining the navigable conditions needed for the river's commerce to June 30, 1902. If anything more than maintenance shall be contemplated, operations should be carried on either (1) under the continuing-contract system, or (2) by a suitable plant owned and operated by the Government. The cost of completing the improvement by the first of these methods in accordance with the last project and estimate submitted to Congress would be $500,000 in round numbers. The work could be done in two years, but it would probably cost not less than $20,000 annually for subsequent satisfactory maintenance of the improvement. The best method of operations, however, and that which would, in my judgment, best adapt itself to and keep pace with the requirements of commerce on this stream at the least possible cost, would be for the Government to provide and operate its own dredging plant. I am, as a rule, opposed to this method, but the conditions to be dealt with make it peculiarly applicable and expedient in this case, where the chief requisites are a progressive improvement and an up-to-date maintenance.

Its cost may be estimated at $125,000 for the first year, including purchase or construction of plant and operating it, and about $50,000 annually for the next five years for operation and repairs. After that time it is probable that the improvement could be adequately maintained by an annual expenditure not exceeding $20,000.

The river is in the collection district of Huron, Mich., and the nearest port of entry is Port Huron, Mich. There is a light-house at the mouth of the river.

Estimated cost of successive projects, 1867 to 1882	$289,795.00
Estimated cost of project for 1882	446,000.00
Total	735,795.00
Carried to surplus fund	1,000.00
Whole amount expended to June 30, 1901	771,532.71

Money statement.

July 1, 1900, balance unexpended	$46,626.77
June 30, 1901, amount expended during fiscal year	30,409.48
July 1, 1901, balance unexpended	16,217.29
July 1, 1901, outstanding liabilities	10.00
July 1, 1901, balance available	16,207.29
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901 Submitted in compliance with requirements of sundry civil act of June 4, 1897.	50,000.00

Appropriations for improving Saginaw River, Michigan.

June 23, 1866	$67,500	August 5, 1886	$33,750
March 2, 1867	28,000	August 11, 1888	65,000
July 25, 1868 (allotment)	9,000	September 19, 1890	75,000
July 11, 1870	1,500	July 13, 1892	100,000
June 23, 1874	15,000	August 18, 1894	40,000
March 3, 1875	30,000	June 3, 1896	40,000
August 14, 1876	11,000	March 3, 1899	40,000
June 18, 1878	25,000		
March 3, 1879	8,000	Total	788,750
June 14, 1880	15,000	Carried to surplus fund	1,000
March 3, 1881	10,000		
August 2, 1882	125,000	Balance	787,750
July 5, 1884	50,000		

Abstracts of contracts in force.

Name of contractor.	Date of approval.	Date of beginning.	Date of expiration.	Completed.
Bay City Dredging Co	Sept. 2, 1899	Aug. 28, 1899	[a] June 30, 1900	Aug. 27, 1900
G. H. Breymann & Bros	Aug. 18, 1899	do	Aug. 31, 1900	July 24, 1900

[a] Extended to September 30, 1900.

COMMERCIAL STATISTICS, SAGINAW RIVER, MICHIGAN, FOR CALENDAR YEAR ENDING DECEMBER 31, 1900.

Entrances and clearances.

Calendar year.	Number.	Tonnage.	Calendar year.	Number.	Tonnage.
1893	1,290	393,487	1897	1,034	330,031
1894	226	72,707	1898	996	304,827
1895	226	72,689	1899	889	336,269
1896	189	48,752	1900	798	249,931

Receipts and shipments by vessel.

[Compiled from statements furnished by Deputy Collectors of Customs C. M. Stewart, of Saginaw East Side, and D. C. Brawn, of Bay City, Mich.]

Articles.	Received.	Shipped.
	Tons.	*Tons.*
Brick	80	....
Cedar posts	1,885	....
Coal	23,480	350,596
Farm products, miscellaneous	....	722
Fish	1,060	15
Flour	22	4,400
Fruit, miscellaneous	12	....
Grain	688	2,000
Gravel	200,080	....
Hay and feed	200	140
Iron and ore	550	....
Lath	1,190	....
Leather	....	4
Lime and cement	72	55
Live stock	131	....
Logs	73,690	....
Lumber	135,754	22,621
Machinery	15,000	10,000
Merchandise, general	3,000	2,300
Paper	400	136
Salt	....	8,838
Shingles	26	....
Stone	16,869	....
Tan bark	750	....
Telegraph poles	2,500	1,000
Unclassified freight	3,952	....
Pickets	872	....
Total	482,253	402,827

O O 4.

IMPROVEMENT OF SEBEWAING RIVER, MICHIGAN.

The original channel from Saginaw Bay to the mouth of Sebewaing River had an available depth of scant 4 feet. The first improvement was made in 1875, by which an entrance depth of 6 feet was provided, through a narrow channel, at a cost of $8,000, and this depth was increased to 7 feet in 1880–81 at a further cost of $7,000. The river and harbor act of June 3, 1896, appropriated $5,000 for further operations, in accordance with a plan of improvement submitted in report of November 30, 1895 (printed as House Doc. No. 71, Fifty-fourth Congress, first session, and also in the Report of the Chief of Engineers for 1896, p. 7743), which provides for extending the channel to the 8-foot contour in Saginaw Bay, a distance of about 15,000 feet from the river's mouth, and increasing its width and depth to 100 feet and 8 feet, respectively. The estimated cost was $37,000.

No work was done up to June 30, 1899, as sufficient funds were not supplied for commencing it until the appropriation contained in the river and harbor act of March 3, 1899, became available.

Advertisement for proposals was published June 30, bids opened July 24, 1899, and contract finally entered into with Campbell Brothers, of Sault Ste. Marie, Mich., August 21. Considerable delay attached to the award and execution of this contract on account of preliminary investigations necessary to determine the propriety or expediency of awarding it to the lowest bidder. Because of the delays due to stormy weather and the exposed location of the work operations under the contract were not commenced until October 14, 1899. They were continued up to November 15, 1900, except while the plant was in winter quarters (December 1, 1899, to May 1, 1900). The amount of material excavated, loaded in scows, and deposited at the designated dumping grounds, to June 30, 1900, was only 10,770 cubic yards; but in addition a large amount was cast over by the dredge, to provide suitable channels for operating and berthing the plant. Work again ceased for the winter on November 15, 1900, but was resumed April 24, 1901, and has continued to the present time. The progress has been very slow, but the contractor promises that he will very shortly put additional plant on the work. Some commercial benefits have resulted from the limited progress thus far made.

The total amount of money estimated as necessary for completing the contemplated improvement is now available, and there is therefore no occasion for any further appropriation or estimate.

The river is in the collection district of Huron, Mich., and the nearest port of entry is Port Huron, Mich. There is a light-house at the mouth of Saginaw River.

Original estimated cost of work, 1895	$37,000.00
Whole amount expended on present project to June 30, 1901	8,525.85

Money statement.

July 1, 1900, balance unexpended	$35,350.37
June 30, 1901, amount expended during fiscal year	7,076.22
July 1, 1901, balance unexpended	28,474.15
July 1, 1901, outstanding liabilities	2,085.34
July 1, 1901, balance available	26,388.81
July 1, 1901, amount covered by uncompleted contracts	26,388.81

Appropriations for improving Sebewaing River, Michigan.

March 3, 1875 (river and harbor)	$8,000
June 14, 1880	7,000
June 3, 1896	5,000
March 3, 1899	32,000
Total	52,000

CONTRACT IN FORCE.

Contracts in force with Campbell Brothers for dredging Sebewaing River, Michigan, approved September 13, 1899; date of beginning work, October 14, 1899; date of expiration, September 30, 1900. Extended to December 31, 1900, and to December 1, 1901.

COMMERCIAL STATISTICS, SEBEWAING RIVER, MICHIGAN, FOR CALENDAR YEAR ENDING DECEMBER 31, 1900.

Receipts and shipments.

[Compiled from statement furnished by Messrs. John C. Liken & Co., Sebewaing, Mich.]

Articles.	Received.	Shipped.
	Tons.	*Tons.*
Brick		7,000
Cedar posts	200	500
Coal	1,500	60,000
Farm products, miscellaneous		28,000
Fish		200
Flour		5,400
Fruit, miscellaneous		675
Grain		4,800
Hay and feed		2,000
Lath	390	400
Lime and cement	550	750
Live stock		1,500
Logs	11,250	
Lumber	1,500	4,500
Machinery	60	
Merchandise, general	2,800	1,000
Salt	200	
Shingles	375	
Stone	3,125	
Telegraph poles	250	
Unclassified freight	2,000	1,500
Total	24,200	118,225

NOTE.—Majority shipped by rail. Harbor still unfinished and incomplete.

O O 5.

IMPROVEMENT OF HARBOR OF REFUGE AT SANDBEACH, LAKE HURON, MICHIGAN.

This improvement was commenced in 1872, and by 1877 its construction was far enough advanced to afford shelter from the most dangerous storms, though it was not until 1885 that all of the three breakwaters were completed so as to give protection against storms coming from any and all directions. The combined length of these structures as they now stand is 8,132 feet, and they cover an area of about 650 acres, in 119 of which the depth of water is 20 feet or more. A condensed history of the work to June 30, 1896, is given in the report of the Chief of Engineers for that year, pages 2730–2731, and operations since that date have been confined to occasional repairs of breakwaters, by day labor, under the supervision of the custodian of the harbor.

The total expenditure connected with this improvement to June 30, 1901, including original construction, dredging, maintenance, and the supervision and control of vessels entering for shelter, was $1,216,011.43. Of this amount $5,989.06 were spent during the last fiscal year for custody, supervision, office expenses, ordinary repairs to breakwaters, and beginning of plans for concrete superstructure.

The number of vessels that entered the harbor for refuge during the last fiscal year was 1,276, with a total tonnage of 804,836. The grand total of vessels that have found shelter there from 1877 to 1900, inclusive, is 28,713, the tonnage of which aggregated 10,427,111. The vessels sheltered in 1877 averaged 289 tons each, while the average registered tonnage for the year 1900 was 603 tons. Further statistics of this nature are given in the tabular statements which accompany this report.

The river and harbor act of March 3, 1899, provided for commencing the work of rebuilding the superstructure of the main breakwater in concrete, and authorized the work to be inaugurated under the continuing contract system. It was found practicable to prepare satisfactory plans and specifications in time to begin operations before the close of the last fiscal year, but it is expected they will be entered upon during the present working season and pressed forward with all possible vigor. Funds now available for this purpose and for the usual expenses of custody, supervision, and ordinary repairs amount to $290,000, in round numbers. An additional appropriation of $60,000 will be needed for the year 1903, of which $50,000 is to meet continuing contract obligations and $10,000 to cover expenses of custody, supervision, and maintenance, including ordinary repairs of harbor piers other than the main breakwater.

Sandbeach is in the collection district of Huron, Mich., and the nearest port of entry is Port Huron, Mich. One light-house and three beacons mark the entrances to the harbor, and there is a life-saving station inside.

Original estimated cost of the work	$1,442,500.00
Amount carried to surplus fund	30,000.00
Whole amount expended to June 30, 1901	1,216,011.43

Money statement.

July 1, 1900, balance unexpended		$296,084.68
June 30, 1901, amount expended during fiscal year		5,989.06
July 1, 1901, balance unexpended		290,095.62
July 1, 1901, outstanding liabilities		519.11
July 1, 1901, balance available		289,576.51
Amount (estimated) required for completion of existing project		50,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901:		
For works of improvement	$50,000.00	
For maintenance of improvement	10,000.00	
		60,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

Appropriations for improving harbor of refuge at Sandbeach (Lake Huron), Michigan.

March 3, 1871	$100,000.00	August 18, 1894	$20,000.00
June 10, 1872	100,000.00	June 3, 1896	16,000.00
March 3, 1873	75,000.00	March 3, 1899	50,000.00
June 23, 1874	75,000.00	June 6, 1900	150,000.00
March 3, 1875	100,000.00		
August 14, 1876	75,000.00	Total	1,536,000.00
June 18, 1878	100,000.00	Carried to surplus fund	30,000.00
March 3, 1879	75,000.00		
June 14, 1880	75,000.00		1,506,000.00
March 3, 1881	50,000.00	September 4, 1897, amount collected on account of damage to piers and deposited to the credit of appropriation	107.05
August 2, 1882	75,000.00		
July 5, 1884	75,000.00		
August 5, 1886	75,000.00		
August 11, 1888	70,000.00		
September 19, 1890	30,000.00		
July 13, 1892	150,000.00		1,506,107.05

TABLE No. 1.—*Summary of vessels sheltered in the harbor of refuge at Sandbeach, Michigan, from July 1, 1900, to June 30, 1901.*

Direction of wind at time of entering.	1900.						1901.			Total.
	July.	Aug.	Sept.	Oct.	Nov.	Dec.	April.	May.	June.	
North:										
Steam	24	13	21	15	11	1	4	12	4	105
Sail	2	5	3	2	1	0	3	1	1	18
Tows	9	0	9	7	1	0	1	3	3	33
Total	35	18	33	24	13	1	8	16	8	156
Northwest:										
Steam	21	1	13	15	18	6	0	6	11	91
Sail	3	0	1	3	4	2	0	4	1	18
Tows	6	0	3	6	12	1	0	0	6	34
Total	30	1	17	24	34	9	0	10	18	143
West:										
Steam	38	19	16	15	61	10	0	23	14	196
Sail	5	3	2	8	9	0	0	0	9	36
Tows	19	0	9	16	33	2	0	14	2	95
Total	62	22	27	39	103	12	0	37	25	327
Southwest:										
Steam	30	22	38	15	34	4	2	11	25	181
Sail	5	7	14	6	6	0	0	3	4	45
Tows	0	1	15	0	15	0	0	1	0	32
Total	35	30	67	21	55	4	2	15	29	258
South:										
Steam	8	8	5	11	13	2	4	5	2	58
Sail	1	3	4	6	2	0	0	0	2	18
Tows	0	0	0	0	3	0	1	0	0	4
Total	9	11	9	17	18	2	5	5	4	80
Southeast:										
Steam	14	18	16	15	6	0	3	1	13	86
Sail	1	2	7	5	0	1	1	2	0	19
Tows	0	0	0	0	4	0	0	0	1	5
Total	15	20	23	20	10	1	4	3	14	110
East:										
Steam	1	1	1	1	3	0	0	2	4	13
Sail	0	0	0	2	0	0	0	0	0	2
Tows	0	0	0	2	3	0	0	1	0	6
Total	1	1	1	5	6	0	0	3	4	21
Northeast:										
Steam	1	19	12	20	12	4	0	24	16	108
Sail	1	4	5	1	3	1	0	7	1	23
Tows	0	10	0	27	4	2	0	7	0	50
Total	2	33	17	48	19	7	0	38	17	181
Total each month:										
Steam	137	101	122	107	158	27	13	84	89	838
Sail	18	24	36	33	25	4	4	17	18	179
Tows	34	11	36	58	75	5	2	26	12	259
Total	189	136	194	198	258	36	19	127	119	1,276

TABLE No. 2.—*Classified table of tonnage, by months, sheltered in the harbor of refuge at Sandbeach, Michigan, from July 1, 1900, to June 30, 1901.*

Date.	Steam.		Sail.		Tows.		Total.	
	Number.	Tonnage.	Number.	Tonnage.	Number.	Tonnage.	Number.	Tonnage.
1900.								
July	137	93,403	18	1,811	34	14,837	189	110,051
August	101	83,150	24	2,851	11	5,535	136	91,536
September	122	95,189	36	3,924	36	15,906	194	115,019
October	107	72,575	33	4,367	58	26,354	198	103,296
November	158	132,715	25	3,301	75	45,087	258	181,103
December	27	27,794	4	716	5	3,892	36	32,402
1901.								
April	13	14,301	4	591	2	1,942	19	16,834
May	84	57,041	17	1,866	26	11,425	127	70,332
June	89	75,907	18	1,925	12	6,431	119	84,263
Total	838	652,075	179	21,352	259	131,409	1,276	804,836

TABLE No. 3.—*Number and tonnage of vessels sheltered in the harbor of refuge at Sandbeach, Michigan, 1877 to 1900, inclusive.*

Calendar year.	Steam.	Sail.	Tow.	Total.	Total vessels.	Average tonnage.
	Tons.	*Tons.*	*Tons.*	*Tons.*		
1877	63,966	27,699	50,954	142,619	493	289
1878	104,025	39,699	99,282	243,006	781	311
1879	133,080	45,750	100,096	278,926	921	303
1880	158,720	55,630	147,260	361,610	1,317	275
1881	144,645	55,960	127,855	328,460	1,176	279
1882	146,132	26,504	114,067	282,703	1,022	280
1883	177,122	32,713	114,091	323,926	1,139	284
1884	156,518	34,724	122,980	314,222	1,142	275
1885	196,364	29,426	151,607	377,397	1,158	326
1886	196,335	33,790	140,862	370,987	1,304	284
1887	271,327	33,689	153,087	458,103	1,447	317
1888	271,917	39,756	202,191	513,864	1,624	316
1889	287,719	37,922	165,896	493,531	1,512	326
1890	325,852	38,826	169,104	533,782	1,575	339
1891	296,917	27,076	171,067	491,060	1,341	366
1892	362,486	29,465	162,605	554,556	1,441	385
1893	243,451	20,897	113,915	378,263	982	385
1894	321,511	22,961	134,034	478,506	1,150	416
1895	356,532	26,898	167,327	550,668	1,204	451
1896	246,447	24,621	105,988	377,087	1,078	351
1897	304,460	21,151	157,776	479,387	1,205	398
1898	505,630	18,090	107,176	630,980	1,204	523
1899	590,547	20,854	81,143	692,544	1,254	544
1900	617,161	20,919	124,924	763,004	1,266	603
Total	6,480,894	765,020	3,181,197	10,427,111	28,781	....

O O 6.

IMPROVEMENT OF MOUTH OF BLACK RIVER, MICHIGAN.

The bar and middle ground in the St. Clair River, at the mouth of the Black, were dredged to a depth of 15 feet in the years 1872–1875, redredged to 16 feet in 1889–1892, and again to the same depth in 1897.

No work has been done since dredging operations were suspended in 1897, and the expenditure for the last fiscal year, amounting to $750.01, was applied to engineering and office contingencies.

All previous experience shows that the shoal will reform gradually, and it is very desirable that means be at hand to prevent the navigable depth being so reduced as to seriously affect the very considerable through commerce that passes over this area in vessels of moderate draft rather than pass around it via the main channel, which must be used by those drawing over 14 feet. An appropriation of $5,000, in addition to funds now available for this purpose, is recommended as a judicious precautionary measure.

The river is in the collection district of Huron, Mich., and the nearest port of entry is Port Huron, Mich. The nearest light-house is at Fort Gratiot, distant about 2 miles.

Original estimated cost (1871) of removing middle ground to depth of—	
15 feet	$67,320.00
18 feet	157,520.00
Whole amount expended to June 30, 1901	93,629.88

Money statement.

July 1, 1900, balance unexpended	$5,620.13
June 30, 1901, amount expended during fiscal year	750.01
July 1, 1901, balance unexpended	4,870.12
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement, in addition to the balance unexpended July 1, 1901	5,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

Appropriations for improving St. Clair River at mouth of Black River, Michigan.

Mouth of Black River, in St. Clair River, Michigan:	
June 10, 1872	$15,000
St. Clair River, at mouth of Black River, Michigan:	
March 3, 1873	15,000
June 23, 1874	15,000
March 3, 1875	10,000
June 18, 1878	1,500
Mouth of Black River, Michigan:	
August 11, 1888	$10,000
September 19, 1890	10,000
July 13, 1892	10,000
August 18, 1894	4,000
June 3, 1896	4,000
March 3, 1899	4,000
Total	98,500

O O 7.

IMPROVEMENT OF BLACK RIVER AT PORT HURON, MICHIGAN.

This improvement was commenced under the river and harbor act of September 19, 1890, and the present project contemplates dredging the river channel to a depth of 16 feet from the mouth to Washington avenue. Progress of the work to June 30, 1896, is summarized in the Report of the Chief of Engineers for that year, pages 2733 and 2734, and operations since that time have been limited to work done in 1897, when the narrow upstream section of the improved channel and some shoal spots in the wider section below were redredged in order to restore the required navigable depth and the partial repetition of this work, as far as funds would permit, in July and August, 1900.

The expenditure for the last fiscal year, amounting to $3,818.68, was applied to engineering and general office contingencies and dredging. A thorough examination of the improved section of river in April, 1900, showed that every evidence of the dredging done above the Grand Trunk Railway bridge had been obliterated, the maximum available draft that could be carried over the shoalest parts of the channel being scant 9 feet; but up to that bridge a draft of a little over 12 feet could be carried. The channel, therefore, was redredged last season to such extent as funds available would permit. Advertisement for proposals to do the work were published June 20, 1900, bids opened June 30, 1900, and contract for the work entered into. Dredging was begun July 14, and completed August 14, 1900, the total amount taken out under the contract being 23,214 cubic yards.

All previous experience, however, indicates that little or no evidence of the work will be found above the Grand Trunk Railway bridge at the opening of next season's navigation.

The total estimated cost of the improvement from the mouth of the river to the Grand Trunk Railway bridge, with widths varying from 75 to 160 feet, according to locality, was $75,000. No estimate of cost of continuing the work to Washington avenue, as required by the subsequent act, was called for by Congress, and none has been submitted. The total amount appropriated to date is $47,000, and it will require the remaining $28,000 of the estimate to restore the channel and complete it with depth of 16 feet to the limits contemplated by the approved project. If, however, further operations be limited to maintenance of the improvement as it now exists, an appropriation of $8,000 for the year ending June 30, 1903, will suffice.

This river is in the collection district of Huron, Mich., and the nearest port of entry is Port Huron, Mich. The nearest light-house is at Fort Gratiot, distant about 2 miles.

Original estimated cost of 15-foot channel, 1889	$55,110.00
Original estimated cost of 16-foot channel, 1891	75,000.00
Whole amount expended to June 30, 1901	46,304.97

Money statement.

July 1, 1900, balance unexpended		$4,513.71
June 30, 1901, amount expended during fiscal year		3,818.68
July 1, 1901, balance unexpended		695.03
Amount (estimated) required for completion of existing project		28,000.00
Amount than can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901:		
For works of improvement	$20,000.00	
For maintenance of improvement	8,000.00	
		28,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

Appropriations for improving Black River, Michigan, at Port Huron.

September 19, 1890	$25,000
July 13, 1892	10,000
August 18, 1894	4,000
June 3, 1896	4,000
March 3, 1899	4,000
Total	47,000

CONTRACT IN FORCE.

Contract in force with Edmund Hall for dredging Black River at Port Huron, Mich., approved July 12, 1900; date of beginning work, July 14, 1900; date of expiration, September 30, 1900.

COMMERCIAL STATISTICS, BLACK RIVER, MICHIGAN, FOR CALENDAR YEAR ENDING DECEMBER 31, 1900.

Entrances and clearances.

Calendar year.	Number.	Tonnage.	Calendar year.	Number.	Tonnage.
1889	1,612	578,489	1895	587	60,650
1890	2,225	547,954	1896	628	72,950
1891	2,320	598,430	1897	645	121,748
1892	(a)	(a)	1898	216	82,410
1893	602	71,415	1899 (estimated)	504	110,860
1894	595	68,760	1900 (estimated)	5,796	1,607,356

a Not stated.

Receipts and shipments by vessel.

[Compiled from statement furnished by Mr. John L. Preston, special deputy collector of customs, Port Huron, Mich.]

Articles.	Received.	Shipped.
	Tons.	*Tons.*
Brick	9,812	....
Cedar posts	275	....
Coal	42,065	....
Lath	259	....
Lime and cement	1,925	....
Logs	3,250	....
Lumber	10,938	181
Salt	98	....
Shingles	642	....
Stone	625	....
Wood	5,502	....
Pulp wood	30,000	....
Tile	360	....
Fire brick	180	....
Total	105,981	181

O O 8.

IMPROVEMENT OF PINE RIVER, MICHIGAN.

The project of improvement now in course of execution in this river provides for dredging it from its mouth to Belknap's brickyard, a distance of about 5,800 feet, the channel to be 100 feet wide and 14 feet deep for a distance of 2,500 feet upstream, and thence 75 feet wide, with a depth of 12 feet for the remaining 3,300 feet. An outline of the work done to June 30, 1897, is given in the Annual Report of the Chief of Engineers for that year, page 3024, and no operations were in progress from that time until the summer of 1899.

The river and harbor act approved March 3, 1899, appropriated $5,560 for completing the improvement in accordance with the approved project, and this result was duly accomplished, the work being done under contract of August 8, 1899, with James Rooney, of Toledo, Ohio, from August 28 to October 19, 1899. The total amount of material dredged was 36,652 cubic yards.

The cost of the whole improvement was originally estimated in 1895 at $10,560, but the work was accomplished at a total cost of $8,966.89, including all contingencies to June 30, 1901. A balance of $1,593.11 from the last appropriation is on hand, which will probably suffice to meet all cost of maintenance and general contingencies of engineering, office, etc., for some time to come. Further appropriation is therefore unnecessary at present.

The river is in the collection district of Huron, Mich. The nearest port of entry is Port Huron, Mich. The nearest light-house is at Fort Gratiot, distant about 13 miles.

Original estimated cost of work, 1895	$10,560.00
Whole amount expended on present project to June 30, 1901	8,966.89

Money statement.

July 1, 1900, balance unexpended	$1,913.11
June 30, 1901, amount expended during fiscal year	320.00
July 1, 1901, balance unexpended	1,593.11

Appropriations for improving Pine River, Michigan.

March 3, 1875	$5,000
June 3, 1896	5,000
March 3, 1899	5,560
Total	15,560

COMMERCIAL STATISTICS, PINE RIVER, MICHIGAN, FOR CALENDAR YEAR ENDING DECEMBER 31, 1900.

Entrances and clearances.

Calendar year.	Number.	Tonnage.
1898	348	107,800
1899	306	822,660
1900	488	8,294

Vessels trading to port.

Description.	Number.	Tonnage.
Steamers	451	3,667
Schooners	3	480

Receipts and shipments by vessel.

[Compiled from statement furnished by Mr. W. B. Morse, deputy collector of customs, St. Clair, Mich.]

Articles.	Received.	Shipped.
	Tons.	*Tons.*
Brick	....	5,178
Coal	150	....
Stone	220	....
Total	370	5,178

O O 9.

IMPROVEMENT OF BELLE RIVER, MICHIGAN.

An improvement of this river was made between 1880 and 1885, at a total cost of $14,000, by dredging a channel 50 feet wide and 13 feet deep for a distance of about 6,000 feet from the mouth. This depth gradually decreased until the river and harbor act of June 3, 1896, appropriated $5,000 for redredging the channel to a navigable depth of 15 feet from the mouth to the first bridge above, and from there to the second bridge to a depth of 14 feet. Operations under this project to June 30, 1898, are summarized in the Report of the Chief of Engineers for that year, pages 2589–2590, and none were in progress from that time until the summer of 1899.

The river and harbor act of March 3, 1899, appropriates $10,000 to complete the improvement, and this was accomplished during the ensuing summer and fall by work done under contract, which was entered into with James Rooney, of Toledo, Ohio, August 8, 1899. Operations under this contract were commenced August 22 and completed October 3, 1899, with no incident worthy of note or comment. The amount of material excavated was 52,074 cubic yards.

No additional appropriation is necessary, as the unexpended balance of the last one will provide for all probable expenses of maintenance, supervision, etc., for some considerable time to come.

The river is in the collection district of Huron, Mich., and the nearest port of entry is Port Huron, Mich. The nearest light-house is at St. Clair Flats Canal, Michigan, distant about 17½ miles.

Original estimated cost of work, 1895	$21,340.00
Whole amount expended on present project to June 30, 1901	10,940.46

Money statement.

July 1, 1900, balance unexpended	$4,699.12
June 30, 1901, amount expended during fiscal year	639.58
July 1, 1901, balance unexpended	4,059.54

Appropriations for improving Belle River, Michigan.

March 3, 1881 (ice harbor of refuge)	$7,000
August 2, 1882 (ice harbor of refuge)	5,000
July 5, 1884 (ice harbor of refuge)	2,000
June 3, 1896	5,000
March 3, 1899	10,000
Total	29,000

COMMERCIAL STATISTICS, BELLE RIVER, MICHIGAN, FOR THE CALENDAR YEAR ENDING DECEMBER, 31, 1900.

Entrances and clearances.

Calendar year.	Number.	Tonnage.	Calendar year.	Number.	Tonnage.
1897	52	3,092	1899	85	33,272
1898	60	23,743	1900	69	17,680

Belle River is used as a winter harbor, and the entrances and clearances for 1900 include vessels which cleared in the spring of that year and those which entered in the fall of 1900 to go into winter quarters. Total, 37 vessels; aggregate tonnage, 15,666.

Receipts and shipments by vessel.

[Compiled from statement furnished by Mr. R. B. W. Beattie, deputy collector of customs, Marine City, Mich.]

Articles.	Received.	Shipped.
	Tons.	*Tons.*
Cedar posts	101	....
Coal	1,504	....
Gravel	1,098	....
Hay	....	85
Lath	10,050	2,250
Logs	320	....
Lumber	8,902	2,144
Shingles	356	34
Stone	890	....
Wood	150	....
Straw	....	85
Total	23,371	4,548

O O 10.

IMPROVEMENT OF CLINTON RIVER, MICHIGAN.

The improvement of this stream was commenced in 1870, and has been carried on to June 30, 1896, as outlined in the report of the Chief of Engineers for that year, pages 2736–2737. Nothing has been done since then except to redredge the river at several places between its mouth and Mount Clemens during the summer of 1897 at a cost of $7,000, as described in the report for 1898, page 2595.

The object sought by the approved project of improvement is to maintain a channel 8 feet deep from the mouth of the river to the city of Mount Clemens, 8 miles above.

The whole amount expended for the improvement of the river to June 30, 1901, was $68,240.54, of which $51.48 were spent during the last fiscal year.

No work of improvement was in progress during the year.

An examination of the river made just before the close of the fiscal year 1900 showed a general channel depth of 6 feet or better, but slightly less in a few places. It is therefore likely that dredging will be called for to restore the depth required for local navigation and some work done to reenforce the dike at the mouth of the river, on which the maintenance of an entrance channel must mainly depend. Funds now available will probably be expended for these purposes during the current fiscal year; and if this is done, additional funds should be provided for maintenance of the improvement during the year ending June 30, 1903. An appropriation of $5,000 will probably suffice for this purpose.

The river is in the collection district of Detroit, Mich., which is the nearest port of entry. The nearest light-house is 6 miles distant, at St. Clair Flats.

Original estimated cost of work, 1885, as amended in 1899	$34,564.00
Whole amount appropriated and expended prior to adoption of present project	25,500.00
Whole amount expended on present project to June 30, 1901	42,740.54

Money statement.

July 1, 1900, balance unexpended	$6,874.94
June 30, 1901, amount expended during fiscal year	51.48
July 1, 1901, balance unexpended	6,823.46
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement in addition to the balance unexpended July 1, 1901 Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	5,000.00

Appropriations for improving Clinton River, Michigan.

August 30, 1852	$5,000	September 19, 1890	$10,000
July 11, 1870	5,000	July 13, 1892	8,564
March 3, 1871	1,500	August 18, 1894	5,000
March 3, 1881	8,000	June 3, 1896	10,000
August 2, 1882	6,000		
August 5, 1886	6,000	Total	75,064
August 11, 1888	10,000		

COMMERCIAL STATISTICS, CLINTON RIVER, MICHIGAN, FOR CALENDAR YEAR ENDING DECEMBER 31, 1900.

Entrances and clearances.

Calendar year.	Number.	Tonnage.	Calendar year.	Number.	Tonnage.
1896	420	25,822	1899	384	15,260
1897	420	(*a*)	1900	161	14,060
1898	263	3,043			

a Not stated.

Vessels trading to port.

Description.	Number.	Tonnage.
Steamers	96	9,773
Sail vessels	65	4,287

Receipts and shipments by vessel.

[Compiled from statements furnished by Mr. A. Smith, special deputy collector of customs, Detroit, Mich.]

Articles.	Received.	Shipped.
	Tons.	*Tons.*
Cedar posts	360	
Coal	14,238	
Gravel	4,285	
Lath	429	
Lime and cement	228	
Logs	3,125	
Lumber	8,069	
Paper	116	
Shingles	394	
Stone	925	
Staves		250
Mineral water		32
Crushed stone	250	
Total	32,419	282

O O 11.

IMPROVEMENT OF ROUGE RIVER, MICHIGAN.

Under the provisions of the river and harbor act of August 5, 1886, a survey of this river was made with a view to its improvement, and a project prepared for securing a channel depth of 16 feet, with a width of 240 feet, for a distance of 800 feet from the mouth, and thence with a width of 100 feet to the Wabash Railroad bridge, about 2⅔ miles farther up. The estimated cost was $31,690.39. The improvement was commenced in 1888 and completed in November, 1892, after which no further work was done up to June 30, 1899. In the meantime Congress, by joint resolution approved April 11, 1898, authorized a 13-foot channel to be dredged from the Wabash Railroad bridge to Maples road at an expense not to exceed $5,000.

Operations during the fiscal year 1900 were limited to dredging two small shoals by which navigation was seriously obstructed, the work in each case being done by written proposal and acceptance.

Under date of June 20, 1900, advertisement was published inviting proposals for redredging the river channel ~~as far up as the Wabash~~ Railroad bridge, with a view to restoring a navigable depth of 16 feet through this section, and for dredging to a depth of 13 feet between that bridge and the Maples road, as authorized by the joint resolution approved April 11, 1898, to which reference has been made in the first paragraph of this report. Contract for this work was entered into July 17, 1900, with W. A. McGillis & Co., of Cleveland, Ohio, at 11 cents per cubic yard.

Dredging was begun on July 26 and continued until October 25, 1900, when a total of 95,351 cubic yards had been removed and the available funds exhausted; the next river and harbor act should therefore provide for further maintenance of the improvement, and the amount estimated as necessary for this purpose is $7,500.

The river is in the collection district of Detroit, Mich., which city is the port of entry. The nearest light-house is about 5 miles distant, at Grassy Island.

Original estimated cost of the work, 1887	$31,690.39
Whole amount expended to June 30, 1901	46,438.41

Money statement.

July 1, 1900, balance unexpended	$13,602.86
June 30, 1901, amount expended during fiscal year	13,351.27
July 1, 1901, balance unexpended	251.59
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement, in addition to the balance unexpended July 1, 1901 Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	7,500.00

Appropriations for improving Rouge River, Michigan.

August 11, 1888	$10,000
September 19, 1890	10,000
July 13, 1892	11,690
August 18, 1894	5,000
June 3, 1896	5,000
March 3, 1899 (transferred from appropriation for "Constructing turning basin in Rouge River, Michigan")	5,000
Total	46,690

CONTRACT IN FORCE.

Contract in force with W. A. McGillis & Co., for dredging Rouge River, Michigan; approved August 3, 1900; date of beginning work, July 25, 1900; date of expiration, November 27, 1900.

COMMERCIAL STATISTICS, ROUGE RIVER, MICHIGAN, FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1900.

[Compiled from statements furnished by Brownlee & Co. and Detroit Sulphite Fiber Company, Detroit, Mich.]

Articles.	Received.	Shipped.
	Tons.	*Tons.*
Logs	75,000	
Paper		4,600
Telegraph poles	6,107	
Unclassified freight	38,605	
Total	119,712	4,600

APPENDIX P P.

IMPROVEMENT OF WATERS CONNECTING THE GREAT LAKES.

REPORT OF COL. G. J. LYDECKER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1901, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Ship channel connecting the waters of the Great Lakes between Chicago, Duluth, and Buffalo.
2. St. Marys River at the Falls, Michigan.
3. Operating and care of St. Marys Falls Canal, Michigan.
4. Hay Lake Channel, St. Marys River, Michigan.
5. St. Clair Flats Canal, Michigan.
6. Operating and care of St. Clair Flats Canal, Michigan.
7. Detroit River, Michigan.
8. Removing sunken vessels or craft obstructing or endangering navigation.

EXAMINATIONS AND SURVEYS.

9. Waters connecting Lake Superior and Lake Huron, including Hay Lake channel, St. Marys River, Michigan.
10. St. Clair Flats Canal, Michigan.
11. Detroit River, Michigan.

United States Engineer Office,
Detroit, Mich., July 18, 1901.

General: I have the honor to submit herewith the annual report relative to the works in my charge for the fiscal year ending June 30, 1901.

Very respectfully, your obedient servant,

G. J. Lydecker,
Colonel, Corps of Engineers.

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. A.

P P 1.

IMPROVEMENT OF SHIP CHANNEL CONNECTING WATERS OF THE GREAT LAKES BETWEEN CHICAGO, DULUTH, AND BUFFALO.

This improvement was entered upon in accordance with the following provision of the river and harbor act of July 13, 1892:

> For ship channel twenty and twenty-one feet in depth and a minimum width of three hundred feet in the shallows of the connecting waters of the Great Lakes between Chicago, Duluth, and Buffalo, three hundred and seventy-five thousand dollars: *Pr*

vided, That contracts may be entered into by the Secretary of War for such materials and work as may be necessary to carry out the plans proposed by General O. M. Poe, Corps of Engineers, United States Army, dated January twentieth, eighteen hundred and ninety-one, and printed as House Executive Document numbered two hundred and seven, second session, Fifty-first Congress, for such ship channel, to be paid for as appropriations may from time to time be made by law, not to exceed in the aggregate two million nine hundred and sixty-five thousand dollars, exclusive of the amounts herein appropriated.

The estimated total cost was $3,340,000.

Active operations were commenced in the spring of 1893 and continued until June 30, 1900, as outlined in successive annual reports, when the required channel had been obtained at all places specified in the original project, as well as through a number of other shoals whose existence was unknown when that project was adopted.

Operations were in progress in the St. Clair and the St. Marys river sections during the past fiscal year, as follows:

St. Clair River and Lake.—Dredging was in progress in this section from August 20 to December 4, under a contract with Edward J. Hingston, of Buffalo, N. Y., dated July 6, 1900, for time work by dredging plant at the rate of $10.25 per hour working time. The work was distributed over four different shoals in the main channel, as follows: (1) A 17-foot shoal at the lower approach to the St. Clair flats canal was removed between August 20 and September 9, the total excavation being 15,395 cubic yards; (2) a 15-foot shoal near Squirrel Island, and a like shoal near Grande Pointe, about 2⅝ miles above the former, were removed between September 10 and October 3, by dredging 16,003 cubic yards of material; and (3) work was in progress on a series of shoals near the foot of Stag Island until December 4, when operations were closed for the season, the amount of material removed at this point being 44,860 cubic yards. The contract was thereupon closed, with a total excavation in the St. Clair River section of 76,258 cubic yards, at a total cost of $9,376.06 for the work, making the unit cost about 12.3 cents per cubic yard. The character of material excavated ranged from tenacious clay to sand, and mixtures of sand, clay, and cobble or small stones.

During the months of May and June, the U. S. steamer *Hancock*, equipped with sweeping outfit, was engaged in local examinations of the channel at various points between Port Huron and the foot of Lake St. Clair, where obstructions have been reported by vessel masters. In most cases these reports were found to be erroneous, but in several instances the examinations resulted in the discovery of shoal areas which had been previously unknown, but none on which a less depth than 18½ or 19 feet was found.

St. Marys River.—Work was in progress in this section from October 12 to December 10, for widening the channel at the angles above Sailors Encampment and at the head of Little Mud Lake, as follows: Above Sailors Encampment, under agreement after public notice, with Hickler Bros. of Sault Ste. Marie, Mich., for time work, by dredging plant, at $12.75 per hour, the channel was widened 35 feet between October 12 and December 10, by excavating 14,120 cubic yards of sand, bowlders, hard pan, and large angular pieces of limestone rock, at a total cost of $6,612.15, or 47 cents per cubic yard. At head of Little Mud Lake, under similar agreement with H. W. Hubbell & Co., for time work at $13 per hour, 42,204 cubic yards of sand, clay, gravel, and small bowlders were excavated, at a total cost of $6,764.33, being at the rate of about 16 cents per cubic yard. As a result of the work, the width of channel at this point was increased 90 feet.

Extensive examinations with sweeping raft and surveys were in progress in this section throughout the year, as described in the following extracts from a report by Assistant Engineer Benno Rohnert, who personally conducted these operations, and also had immediate supervision of the work of dredging referred to in the preceding paragraph:

Widening angle above Johnson Point.—Public notice dated September 24, 1900. Hickler Brothers, of Sault Ste. Marie, Mich., contractors. Hire of dredge No. 5, tug *Marion*, and two dump scows. Rate, $12.75 per hour.

The widening of the angle above Johnson point, at upper end of cut at Sailors Encampment, was begun on October 12 and, on account of the large fields of running ice, ceased on December 10. The excavated material consisted of sand, bowlders, hardpan, and large angular pieces of limestone rock. There were 14,120 cubic yards, scow measure, removed. The plant was operated five hundred and eighteen hours and thirty-six minutes and was delayed forty-six hours and nine minutes. Two cuts were made the entire length of the bank and a third almost completed. The width of the angle was increased about 35 feet. The cost per cubic yard (including inspector's board) was approximately 47 cents. The limits of the area to be dredged were marked by five buoys. Two gauge boards were placed and a dumping ground staked out.

Widening angle at head of Little Mud Lake, section 2.—Public notice dated September 24, 1900. H. W. Hubbell & Co., of Sault Ste. Marie, Mich., contractors. Rate for services of dredge No. 3, tug *Thos. Hood*, and two dump scows, $13 per hour.

The dredging for widening the angle was begun on October 9 and ceased on December 10. There were 42,204 cubic yards, scow measure, of sand, clay, gravel, and small bowlders excavated. The dredge worked five hundred and twenty hours and twenty minutes and was delayed one hundred and seven hours and nineteen minutes. The cost per cubic yard excavated (including the inspector's board) was 16.1 cents. The width of the angle was increased a much-needed 90 feet. The area to be dredged was indicated by 5 stakes. A gauge board was placed and a dumping ground buoyed out.

Examinations with suspended raft bars.—The examination of St. Marys River for shoals was continued throughout the year. With the exception of about 1½ square miles, the entire area of Mud Lake was swept. A shoal was found near Twin Islands and about 700 feet east of the line of Winter point range targets. It consists of sand covered with bowlders and is clear at a depth of 20.9 feet below the established mean water surface. An area bounded by the lines from Sweets Point light to Squaw Island shoal, to Squaw Island, to Pipe Island Twins, to Hoyt shoal, to Frying Pan Island, to Sweets Point light was swept. Two shoals were found abreast of Detour, Mich. The one is situated about 500 feet below and in line of Watson reefs, and the other extends from the face of Sims dock to a point about 200 feet to the eastward. That below the reefs is clear at a depth of 18.3 feet below the established mean water surface, and the other at 16.2 feet. Both are bowlder shoals. Including what was swept during former years, the entire river from one-half mile above Round Island shoal No. 1 to Point aux Frenes has practically been gone over. The total area swept during the fiscal year was 10½ square miles. Two hundred and twenty-one marker buoys placed on the 21, 23.7, and 27 feet contours were located by transit pointing.

The test of depth of water over Squaw Island shoal showed the least to be 17.8 feet below the established mean water's surface. The chart gives it at 18 feet.

In September the part of channel abreast of Sailors Encampment, in which the schooner *Maida* had been sunk, was swept with raft bars suspended at the improved grade. No obstructions were found.

That part of the angle at the upper end of Little Mud Lake which had been dredged under public notice dated September 24, 1900, was swept in April and found clear. The two black spars and the black gas buoy were placed in proper positions along the bank.

Surveys.—The shoal near Twin Islands was developed by 88 soundings; the one in front of Sims dock, at Detour, by 82, and that below Watson reefs by 53 soundings. They were referenced to 25 marker buoys read in from adjacent triangulation stations. Sketches were made of these shoals and submitted.

Aids to navigation.—Several aids to navigation which were either shifted in position or were newly placed were located by transit pointings from adjacent triangulation stations. Their rectangular coordinates, referred to △ 19, survey of 1879, were computed and are:

Object.	Rectangular coordinates (in feet).		Reported by letter dated—	Remarks.
	East.	*North.*		
Red spar buoy	21,652.7	2,655.0	Sept. 29, 1900	Abreast of Brassar point.
Do	22,431.7	4,168.4	do	Do.
	West.	*South.*		
White light	30,272.25	9,195.70	do	Northwesterly from Brush point.
Front target and light	46,847.20	23,145.26	do	Bernard's private range.
Rear target and light	46,509.86	23,543.44	do	Do.
		North.		
Front target and light	2,694.87	7,131.30	May 4, 1901	East approach to Canadian Canal.
Rear target and light	3,295.75	7,916.80	do	Do.
	East.	*South.*		
Black gas buoy	55,072.0	67,630.0		Angle at head of Little Mud Lake.
Red spar buoy	25,366.8	33,912.4	June 28, 1901	Abreast of Nine Mile Point shoal.
Black spar buoy	59,555.1	90,561.7	do	East channel below Encampment light crib.
Do	59,666.2	90,254.5	do	East channel abreast Encampment light crib.
Do	59,678.3	89,961.7	do	East channel above Encampment light crib.
Red spar buoy	59,853.1	90,413.5	do	East channel abreast Encampment light crib.
Do	59,961.8	89,736.2	do	East channel above Encampment light crib.
Do	59,964.1	89,179.6	do	East channel abreast Johnson dock.
Do	60,261.0	87,126.7	do	21-foot channel abreast Rains hotel.
Red gas buoy	60,298.0	87,600.3	do	Do.
Red spar buoy	58,712.4	94,150.1	do	Abreast of Everens point.
Black spar buoy	64,272.0	78,317.6	July 28, 1900	Abreast Sims dock (private).
Red float light	64,309.3	77,115.3	do	Shoal below Watson reefs (private).
Black spar buoy	62,762.1	75,822.3	do	Watson reefs (private).
Do	64,201.3	76,331.6	do	Watson reefs, official No. 3.
Red spar buoy	62,991.7	75,055.7	do	Watson reefs (private).
Do	66,769.8	74,887.4	do	Hoyt shoal, official No. 2.
Black spar buoy	54,613.9	64,583.9	do	Sweets point, official No. 5.

General.—Tripods over triangulation stations 55, 60, 205, Raber, 206, 207, 227, 231, 235, 209, 210, 211, 213, Fort St. Joe, and 204 were either repaired or rebuilt. The lines of sight between these stations were cleared of brush.

Quantities of material and estimates of cost for desirable improvements of the angles of section 2 and 3 were computed. A report and sketches were prepared and submitted.

A book was prepared containing all rectangular coordinates of triangulation stations, azimuths, distances, and equations of channel lines of St. Marys River.

A special report was made on the location of channel buoys and the striking and grounding of vessels due to their wrong positions submitted.

Proposals were invited May 6 and opened May 28 for time work by dredging plant in removing obstructions to navigation between the head of St. Clair and mouth of Detroit rivers, and contract was entered into June 13 with the Duluth Dredge and Dock Company, of Duluth, Minn., at the rate of $12 per hour, working time, but no work was done before the close of the year.

The total expenditure to June 30, 1901, excluding liabilities then outstanding, was $2,962,072.79, and the total excavation to that date was 10,549,566 cubic yards. The depth now available over the shoalest part of the ship channel between Chicago, Duluth, and Buffalo is 18½ feet, and this limiting depth is confined to that section of the Detroit River which is included between the Lime Kiln Crossing and the south end of Bois Blanc Island.

It is proposed to apply the unexpended balance of the ship-channel appropriations as occasion requires; (1) to widening and deepening the channel at points where such work is needed to make navigation safe and convenient, and (2) to the removal of newly discovered shoals or obstructions in the line of through travel between the specified terminals of the ship channel. No further appropriation for these purposes is required at present.

Money statement.

July 1, 1900, balance unexpended	$416, 224. 41
June 30, 1901, amount expended during fiscal year	[1]35, 519. 14
July 1, 1901, balance unexpended	380, 705. 27
July 1, 1901, outstanding liabilities	3, 003. 47
July 1, 1901, balance available	[2]377, 701. 80
July 1, 1901, amount covered by uncompleted contracts	20, 000. 00

Appropriations for ship channel in the connecting waters of the Great Lakes.

July 13, 1892	$375, 000. 00
March 3, 1893, sundry civil act	875, 000. 00
March 2, 1895, sundry civil act	500, 000. 00
June 11, 1896, sundry civil act	500, 000. 00
June 4, 1897, sundry civil act	1, 090, 000. 00
Total	3, 340, 000. 00
February 19, 1895, repayment of overpayment made R. J. Cram, dredging section 1	2, 778. 06
	3, 342, 778. 06

ABSTRACT OF CONTRACTS IN FORCE DURING THE FISCAL YEAR ENDING JUNE 30, 1901.

Contract dated July 6, 1900, for time work by dredging plant.

Name of contractor: Edward J. Hingston, Buffalo, N. Y.
Rate: $10.25 per hour.
Date of approval: July 24, 1900.
Date of commencement: August 16, 1900.
Date of completion: December 4, 1900.

Contract dated June 13, 1901, for time work by dredging plant.

Name of contractor: Duluth Dredge and Dock Company, Duluth, Minn.
Rate: $12 per hour.
Date of approval: June 24, 1901.
Date of commencement: July 8, 1901.
Date of completion: Indefinite.

P P 2.

IMPROVEMENT OF ST. MARYS RIVER AT THE FALLS, MICHIGAN.

At the time of the adoption of the present project the old State locks, built in 1855, and the lock of 1881 were in operation, giving at the normal stage of water a maximum draft of about 16 feet. To meet the demands of the large and rapidly increasing commerce between Lake Superior and the lower lakes a lock of greater capacity and an increased allowable draft was urgently required.

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[1] Includes $1.14 paid by Treasury Department, account Western Union Telegraph Company.
[2] Includes $500 reserved for expenses office Chief of Engineers.

The project thereupon presented, October 18, 1886, provided as its leading features for constructing a new lock 100 feet wide and 800 feet long between gates, with a single lift of 18 to 20 feet, according to the fluctuation of the upper and lower levels, and depth of 21 feet over the miter sills, the canal and its approaches to be deepened to correspond. The estinated cost was $4,738,865. The essential features of work under this project were completed in 1896, the new lock being opened to navigation August 3 of that year and a channel 25 feet deep having then been completed through the canal and the approaches to the Poe lock. Work from that time to June 30, 1900, consisted in completing the deepening of the canal and channel of approaches to the lock and in the partial reconstruction and extension of canal piers.

The principal work done during the past fiscal year was the construction, by day labor, with material obtained by purchase after public notice, of 240 linear feet crib-pier extension in the northeast approach to the Poe lock, thereby making the total length of this pier 1,431 feet. The crib work is on a pile foundation and in water varying from 26 to 40 feet in depth. The boathouse dock, which is nearly parallel to and about 100 feet north of this pier, was also extended 170 feet, thereby providing a safe and convenient harbor for the Government tugs, scows, pump boat, and quarter boats.

Three stone buildings, each 19 feet square and 10 feet high, were built over the exposed gate engines on the walls of the Poe lock, and two others were partly finished. The first three were built in the fall of 1900, under agreement after public notice, by John B. Irwin, of Sault Ste. Marie, Mich., for $650 each. The other two are being built, under a similar agreement, by M. N. Hunt, for $690 each.

Under public notice of July 13, 1900, agreement was made with Hickler Brothers, of Sault Ste. Marie, for work with derrick scow and crew with diving outfit at the rate of $4.80 per working hour, and $2 per hour for services of attending tug and crew when needed. This outfit worked 99¾ hours between August 7 and 16 in picking up 525 cubic yards of bowlders and placing them as crib filling in the northeast pier extension of the Poe lock; also 96¾ hours, November 3 to 16, in removing stone and bowlders in the Lake George channel, by which the available depth at several shoal places was increased about 2 feet.

Extensive surveys and examinations with sweeping raft were in progress during favorable weather, in continuation of similar work done during the two previous working seasons. As a result of these examinations the full width of natural and improved channels through the entire length of the river, except a distance of about 12 miles in the vicinity of Lime Island, has been thoroughly explored, the contours of depths between 20 and 28 feet, both inclusive, have been accurately located, and all shoals that might menace navigation have been fully developed by soundings.

Further details of operations are given in the accompanying report, prepared by Assistant Engineer Joseph Ripley, under whose immediate supervision they were carried on.

Water levels.—Daily readings of water gauges above and below the locks of the St. Marys Falls Canal, Michigan, were made throughout the year, and their monthly means and differences are as follows:

[Elevations, in feet, above mean tide at New York.]

Month.	Monthly means.		Mean difference.
	Above the locks.	Below the locks.	
1900.	*Feet.*	*Feet.*	*Feet.*
July	602.041	582.548	19.493
August	602.245	582.887	19.358
September	602.729	583.310	19.419
October	602.854	583.385	19.469
November	602.879	583.228	19.651
December	602.490	582.956	19.534
1901.			
January	602.089	583.888	18.201
February	601.824	583.931	17.893
March	601.572	583.705	17.867
April	601.707	582.479	19.228
May	602.038	582.331	19.707
June	602.044	582.565	19.479

The following tables, compiled from our official records, show the maximum, minimum, and mean elevations of the water surface in feet above and below the locks for each calendar month during the past thirty years:

Maximum elevation of the surface of St. Marys River at head of canal, above mean tide at New York, for each calendar month, as selected from the daily noon observations.

Date.	January.	February.	March.	April.	May.	June.
1870						
1871	601.830	601.830	601.380	601.650	601.920	602.440
1872	601.870	601.490	600.870	601.220	602.230	602.120
1873	601.680	601.560	601.480	601.520	602.170	602.250
1874	602.830	601.630	601.660	601.660	602.200	602.950
1875	602.720	601.910	601.490	602.120	602.230	602.860
1876	602.670	601.950	601.670	601.710	602.700	603.200
1877	601.930	601.970	602.070	601.950	601.920	602.400
1878	602.370	601.750	601.640	601.530	601.650	602.040
1879	601.470	601.320	600.770	600.820	601.650	601.160
1880	601.470	601.870	601.470	600.870	601.670	602.840
1881	601.600	601.350	601.310	601.400	601.870	602.050
1882	602.020	601.860	601.860	601.610	601.820	601.970
1883	601.870	601.850	601.870	602.020	601.520	602.250
1884	601.620	601.470	601.830	601.890	601.670	601.440
1885	601.870	602.530	602.090	601.390	602.088	602.078
1886	601.872	601.402	601.222	600.992	601.668	601.768
1887	601.471	601.531	601.451	601.191	601.461	601.768
1888	602.021	600.971	601.191	600.921	601.671	602.487
1889	601.911	601.741	601.761	601.847	602.247	602.087
1890	602.686	601.256	601.096	601.427	601.527	602.007
1891	601.342	601.522	601.192	601.687	601.827	602.217
1892	601.582	601.242	600.722	601.177	601.477	602.577
1893	601.242	601.242	600.842	601.642	601.977	602.527
1894	601.862	601.302	601.442	601.827	602.977	602.927
1895	602.440	601.990	602.060	601.907	602.827	602.727
1896	602.350	602.000	601.950	601.850	603.120	602.830
1897	601.192	601.592	601.782	602.232	602.600	602.800
1898	602.063	601.383	601.283	601.213	601.600	602.050
1899	602.003	601.363	601.353	602.008	602.558	603.028
1900	602.953	602.263	602.068	602.028	602.238	602.208

Maximum elevation of the surface of St. Marys River at head of canal, etc.—Continued.

Date.	July.	August.	September.	October.	November.	December.
1870	....	....	....	....	602.690	602.530
1871	602.970	602.340	602.870	603.020	602.570	601.810
1872	602.870	603.220	603.170	603.130	605.120	602.370
1873	602.730	602.810	603.080	603.190	603.080	604.230
1874	603.040	602.680	602.800	603.210	602.720	603.140
1875	602.800	602.770	603.130	603.700	602.870	602.600
1876	603.550	603.950	604.440	603.900	603.250	602.770
1877	602.420	602.720	602.500	602.700	602.120	602.070
1878	602.210	602.400	602.010	602.200	601.980	601.670
1879	601.620	601.610	601.570	601.870	601.920	601.370
1880	602.250	602.430	602.800	602.440	602.700	603.110
1881	602.350	602.460	602.500	603.300	603.080	602.370
1882	602.340	602.430	602.330	602.500	602.420	602.320
1883	602.440	605.570	602.450	602.670	602.220	601.690
1884	601.718	601.718	603.550	601.898	603.090	601.770
1885	602.358	602.458	602.458	602.298	601.958	602.058
1886	601.968	602.148	602.368	602.458	602.458	602.042
1887	602.128	602.018	602.318	602.838	602.098	601.901
1888	603.047	602.747	602.747	602.697	602.667	602.711
1889	602.467	602.527	602.597	602.617	602.527	602.861
1890	602.567	602.527	602.607	602.567	602.607	602.616
1891	601.777	601.657	602.227	601.827	601.877	602.032
1892	601.877	601.877	602.307	601.947	602.127	601.877
1893	602.827	602.377	602.427	603.127	602.327	602.427
1894	603.177	603.057	603.167	602.887	602.967	602.840
1895	603.227	603.077	604.327	603.427	602.587	602.650
1896	603.150	603.200	603.000	602.510	602.670	602.500
1897	603.050	603.050	603.010	602.850	602.900	602.400
1898	602.550	602.700	603.350	603.150	602.120	602.323
1899	603.158	603.208	603.708	603.038	603.078	603.308
1900	602.908	602.658	603.408	603.978	603.828	603.278

Minimum elevation of the surface of St. Marys River at head of canal, above mean tide at New York, for each calendar month, as selected from the daily noon observations.

Date.	January.	February.	March.	April.	May.	June.
1870	....	....	....	....	....	....
1871	600.670	600.040	600.080	599.920	600.820	601.300
1872	600.680	600.410	599.640	600.140	600.910	601.020
1873	600.930	600.540	600.600	600.520	601.050	601.350
1874	600.830	601.030	600.810	600.620	600.870	601.200
1875	601.000	601.120	601.320	601.370	601.350	601.900
1876	601.500	601.430	601.170	601.140	601.370	600.570
1877	601.600	601.790	601.450	601.350	601.290	601.350
1878	601.060	600.870	600.670	600.370	600.740	601.210
1879	600.470	599.710	599.770	599.970	600.120	600.400
1880	599.870	599.690	599.620	599.230	600.170	601.120
1881	600.900	600.830	600.870	600.650	601.000	600.920
1882	600.870	600.770	600.370	600.370	601.000	600.820
1883	600.200	600.540	600.640	600.410	600.370	600.770
1884	600.720	600.470	600.570	600.130	600.490	600.890
1885	601.010	600.790	600.590	600.550	600.790	601.138
1886	600.762	600.442	600.642	600.642	600.888	601.048
1887	600.521	600.311	600.331	600.291	599.901	601.021
1888	600.391	600.351	600.121	600.181	600.451	601.347
1889	600.621	600.381	600.611	600.591	600.877	601.207
1890	600.606	600.116	600.156	599.856	600.457	601.047
1891	600.422	600.372	600.432	600.432	600.687	600.677
1892	600.332	599.962	600.082	599.162	600.327	600.827
1893	599.332	599.622	599.942	599.562	600.677	601.327
1894	600.062	600.602	600.142	600.162	601.527	601,527
1895	601.560	601.360	600.860	600.990	601.487	601.777
1896	601.000	600.940	600.930	600.550	600.180	602.150
1897	601.182	600.932	600.932	601.002	601.500	601.720
1898	600.453	600.333	600.513	600.413	600.450	600.770
1899	600.883	600.863	600.723	600.603	601.158	601.508
1900	600.713	601.063	601.303	601.413	601.428	600.848

Minimum elevation of the surface of St. Marys River at head of canal, etc.—Continued.

Date.	July.	August.	September.	October.	November.	December.
1870	....	....	....	....	601.190	601.030
1871	598.910	601.210	601.140	600.920	600.770	600.520
1872	601.120	601.820	601.770	601.420	601.520	601.180
1873	601.050	602.310	601.730	601.620	601.680	601.330
1874	601.760	601.650	601.190	602.060	601.600	601.500
1875	601.950	602.000	602.400	601.700	601.470	601.000
1876	602.690	602.700	602.890	602.340	602.280	601.750
1877	601.650	601.990	601.740	601.420	601.320	601.120
1878	601.250	601.350	600.810	601.120	601.120	600.670
1879	600.670	600.850	599.770	600.570	600.350	599.670
1880	601.510	601.130	601.530	600.650	601.300	600.770
1881	601.020	600.770	601.400	602.020	601.750	601.630
1882	601.520	601.680	601.690	601.380	601.470	600.620
1883	601.050	601.420	601.260	599.970	600.320	600.520
1884	601.058	601.038	601.178	601.198	601.030	600.950
1885	601.278	601.778	601.138	601.358	601.378	600.752
1886	601.238	601.428	600.988	601.078	601.048	600.572
1887	601.388	601.158	601.178	601.118	601.018	600.551
1888	601.787	601.807	601.887	601.607	601.607	601.021
1889	601.327	601.127	601.657	601.567	601.347	600.411
1890	601.607	601.387	601.347	600.587	601.177	600.516
1891	600.577	600.877	598.927	600.627	600.827	599.772
1892	600.827	600.877	601.017	600.867	600.477	600.472
1893	601.377	601.677	600.877	600.577	601.177	600.382
1894	602.177	602.227	601.727	601.977	601.407	601.357
1895	602.077	601.777	601.777	602.027	601.677	601.430
1896	602.150	602.200	602.150	601.580	601.200	601.550
1897	601.650	601.950	602.150	601.980	601.300	601.000
1898	601.440	600.700	601.700	601.190	601.050	601.223
1899	600.958	602.258	602.458	602.008	602.078	601.878
1900	601.898	601.658	601.788	602.188	602.208	602.018

Mean elevation of the surface of St. Mary's River at head of canal, above mean tide at New York, for each calendar month, as determined from the daily noon observations.

Date.	January.	February.	March.	April.	May.	June.
1870	....	....	....	....	....	....
1871	601.165	601.002	600.738	600.869	601.446	601.856
1872	600.948	600.864	600.628	600.580	601.469	601.647
1873	601.285	601.109	601.138	601.152	601.709	601.845
1874	601.471	601.314	601.205	601.084	601.501	601.930
1875	601.696	601.448	601.407	601.657	601.961	602.267
1876	601.644	601.592	601.337	601.373	602.097	602.676
1877	601.885	601.860	601.746	601.621	601.625	601.848
1878	601.473	601.215	601.114	601.098	601.373	601.630
1879	600.825	600.425	600.182	600.311	600.685	600.824
1880	600.328	600.293	600.199	600.217	600.957	601.714
1881	601.199	601.105	601.126	601.011	601.437	601.665
1882	601.489	601.271	601.154	601.103	601.514	601.608
1883	601.145	601.049	601.056	601.123	601.118	601.485
1884	601.131	600.940	600.854	600.684	601.055	601.150
1885	601.247	601.135	600.998	600.822	601.406	601.741
1886	601.004	600.839	600.846	600.822	601.301	601.467
1887	600.945	600.802	600.773	600.631	600.995	601.448
1888	600.982	600.594	600.645	600.635	601.236	602.085
1889	601.828	601.088	601.060	601.055	601.616	601.795
1890	601.284	600.730	600.723	600.657	601.120	601.704
1891	600.662	600.773	600.627	600.801	601.231	601.180
1892	600.815	600.457	600.277	600.429	600.940	601.300
1893	600.589	600.391	600.405	600.649	601.225	601.757
1894	601.085	600.951	600.841	601.228	602.204	602.444
1895	601.801	601.665	601.464	601.443	601.845	602.233
1896	601.493	601.487	601.288	601.369	601.986	602.396
1897	601.722	601.415	601.431	601.567	601.910	602.270
1898	601.182	600.956	600.803	600.933	601.221	601.636
1899	601.333	601.177	601.067	601.061	601.919	602.367
1900	601.877	601.786	601.609	601.624	601.816	601.775
Monthly means for above period.	601.229	601.056	600.958	600.987	601.464	601.791

Mean elevation of the surface of St. Marys River at head of canal, etc.—Continued.

Date.	July.	August.	September.	October.	November.	December.	Annual means.
1870	....	....	....	....	....	601.585	....
1871	602.085	601.954	602.005	601.805	601.583	601.190	601.471
1872	602.041	602.367	602.430	602.284	602.137	601.782	601.590
1873	602.288	602.586	602.598	602.480	602.259	602.027	601.869
1874	602.307	602.364	602.348	602.477	602.257	602.150	601.867
1875	602.346	602.363	602.643	602.512	602.233	601.672	602.017
1876	603.145	603.191	603.228	602.890	602.612	602.126	602.326
1877	602.177	602.289	602.055	602.092	601.855	601.689	601.891
1878	601.741	601.699	601.418	601.526	601.444	601.222	601.413
1879	601.124	601.152	601.075	601.099	600.921	600.523	600.762
1880	601.956	601.835	601.991	601.767	601.791	601.517	601.214
1881	601.868	601.788	601.969	602.437	602.334	602.008	601.662
1882	601.952	602.057	601.990	601.906	601.840	601.573	601.621
1883	601.661	602.088	601.752	601.608	601.489	601.229	601.400
1884	601.372	601.417	601.484	601.569	601.677	601.413	601.229
1885	601.919	602.146	601.904	601.721	601.649	601.353	601.508
1886	601.632	601.778	601.654	601.662	601.598	601.162	601.312
1887	601.813	601.696	601.555	601.729	601.500	601.095	601.248
1888	602.242	602.237	602.156	602.140	601.941	601.602	601.537
1889	602.063	602.070	602.063	601.916	601.617	601.229	601.571
1890	602.065	601.974	601.863	601.796	601.656	601.355	601.411
1891	601.292	601.304	601.238	601.294	601.185	600.870	601.038
1892	601.440	601.451	601.509	601.400	601.123	600.841	600.998
1893	601.952	602.086	601.906	601.847	601.792	601.256	601.317
1894	602.582	602.591	602.459	602.501	602.402	602.101	601.945
1895	602.469	602.487	602.658	602.777	602.256	602.048	602.095
1896	602.528	602.545	602.411	601.986	602.015	601.951	601.955
1897	602.498	602.654	602.488	602.271	602.167	601.676	602.006
1898	601.974	602.086	602.223	602.068	601.897	601.810	601.566
1899	602.567	602.718	602.905	602.571	602.613	602.453	602.063
1900	902.041	602.245	602.729	602.854	602.879	602.450	602.140
Monthly means for above period.	602.036	602.104	602.090	602.082	601.891	601.576	....

Maximum elevation of the surface of St. Marys River below the locks, above mean tide at New York, for each calendar month, as selected from the daily noon observations.

Date.	January.	February.	March.	April.	May.	June.
1870	....	....	....	....	....	....
1871	585.120	584.920	584.590	584.120	584.590	584.700
1872	584.130	583.970	584.700	584.000	584.040	583.820
1873	585.300	585.730	585.650	585.270	584.000	584.390
1874	587.620	585.800	585.500	584.970	584.120	584.370
1875	587.410	585.920	585.940	585.880	584.270	584.550
1876	585.520	585,570	585.630	585.470	585.620	585.870
1877	585.770	585.120	584.920	584,690	584.260	584.540
1878	584.820	584.270	583.870	584.040	583.980	584.300
1879	585.570	584.270	583.920	583.590	582.970	582.990
1880	583.870	583.890	583.890	583.350	583.620	584.270
1881	584.560	584.660	584.710	584.210	583.890	584.380
1882	585.800	585.100	584.830	584.850	583.970	584.510
1883	584.838	584.888	584.818	584.648	583.898	584.328
1884	584.348	584.728	584.788	584.248	584.838	584.248
1885	585.548	285.908	585.628	585.368	585.048	584.748
1886	584.488	584.468	584.818	584.658	584.588	584.718
1887	584.826	584.826	584.726	584.826	584.066	584.206
1888	583.987	583.567	584.007	583.867	583.867	584.317
1889	584.967	583.967	583.967	583.267	583.827	583.607
1890	585.707	584.867	583.967	583.727	583.157	583.317
1891	583.967	583.297	583.277	583.177	582.967	582·687
1892	583.267	582.967	583.267	583.827	582.347	582.797
1893	582.727	583.097	582.807	582.897	582.727	583.497
1894	583.387	582.967	583.267	582.767	583.227	583.267
1895	583.647	583.817	583.547	582.927	582.267	582.427
1896	583.507	583.827	583.097	583.267	582.667	582.727
1897	583.567	583.007	583.067	582.167	582.467	582.917
1898	582.867	582.967	582.517	582.037	582.247	582.717
1899	583.697	583.087	583.177	583.047	582.617	583.117
1900	584.297	584.087	583.767	582.967	582.367	582.317

Maximum elevation of the surface of St. Marys River below the locks, etc.—Continued.

Date.	July.	August.	September.	October.	November.	December.
1870					584.460	584.410
1871	585.190	584.960	584.590	584.510	583.910	585.110
1872	584.470	584.420	584.990	584.500	585.660	585.460
1873	584.820	584.920	584.970	585.710	584.920	586.890
1874	584.710	584.810	584.810	584.950	584.850	588.070
1875	584.620	584.850	585.170	584.470	585.590	585.820
1876	586.120	586.190	586.130	586.120	585.390	588.140
1877	584.820	585.030	584.740	584.810	584.560	584.370
1878	584.500	584.340	584.480	584.370	583.770	585.620
1879	583.470	583.670	583.490	583.370	583.120	583.750
1880	584.470	584.580	584.480	584.800	584.770	585.260
1881	584.270	584.320	584.650	584.870	584.830	584.530
1882	584.630	584.700	584.690	584.670	584.480	584.848
1883	584.828	584.948	584.768	584.868	584.698	584.468
1884	584.288	584.348	584.688	584.708	584.698	584.368
1885	584.938	585.088	585.628	584.868	584.618	584.388
1886	584.758	584.688	584.858	584.928	585.238	584.706
1887	584.526	584.436	584.856	584.856	583.666	583.986
1888	584.547	584.347	584.467	584.747	584.147	583.967
1889	584.027	584.027	584.127	584.247	583.467	583.967
1890	583.667	583.767	583.767	583.567	583.467	583.767
1891	582.967	582.967	583.127	582.967	582.707	582.967
1892	583.197	583.267	583.307	583.207	583.167	582.307
1893	583.227	583.097	583.067	583.527	583.007	582.927
1894	583.307	583.667	583.297	583.247	583.167	582.967
1895	582.697	582.757	583.067	583.117	582.497	582.167
1896	582.967	583.047	583.027	582.697	582.567	582.517
1897	583.267	583.427	583.167	583.047	583.117	582.617
1898	582.867	582.897	582.967	582.817	582.717	583.157
1899	583.467	583.667	583.717	583.267	583.047	583.627
1900	582.917	583.137	583.697	583.587	583.567	583.808

Minimum elevation of the surface of St. Marys River, below the locks, above mean tide at New York, for each calendar month, as selected from the daily noon observations.

Date.	January.	February.	March.	April.	May.	June.
1870						
1871	583.790	583.920	583.770	583.500	583.520	584.080
1872	583.440	583.440	583.540	582.570	582.660	583.400
1873	584.560	585.300	584.810	583.300	583.370	583.830
1874	584.920	584.570	584.820	583.790	583.470	583.970
1875	585.620	585.820	585.870	583.870	583.370	584.230
1876	584.570	584.520	584.970	584.680	584.510	584.920
1877	584.890	584.560	584.320	584.050	584.050	583.920
1878	583.620	583.390	583.220	583.320	583.620	583.910
1879	583.730	583.040	583.330	582.390	582.450	582.550
1880	582.550	582.870	582.940	582.270	582.470	583.370
1881	584.080	583.970	584.110	583.050	583.190	583.730
1882	583.900	584.050	583.750	583.450	583.470	583.820
1883	583.828	583.868	584.428	583.258	583.118	583.698
1884	583.898	583.898	583.998	583.348	583.637	584.008
1885	584.248	585.108	585.208	584.228	583.908	584.268
1886	583.838	584.168	584.218	584.318	584.318	584.428
1887	583.656	583.646	583.746	583.716	583.566	583.866
1888	582.837	583.197	583.137	583.497	583.057	583.467
1889	582.857	583.167	582.817	582.427	582.777	583.027
1890	582.807	583.027	582.997	582.267	582.407	582.867
1891	582.677	582.757	582.777	582.397	582.297	582.327
1892	582.147	581.997	582.257	581.297	581.607	582.267
1893	581.597	581.497	581.707	581.597	581.767	582.527
1894	582.027	582.167	582.367	582.077	582.427	582.927
1895	582.347	583.257	582.007	581.797	581.767	582.047
1896	582.247	582.517	582.217	581.687	581.617	582.267
1897	581.967	582.147	582.017	581.467	581.917	582.207
1898	582.017	582.017	581.807	581.517	581.717	582.117
1899	582.017	582.417	582.367	581.817	582.017	582.397
1900	582.317	583.217	583.027	581.817	581.767	581.867

Minimum elevation of the surface of St. Marys River below the locks, etc.—Continued.

Date.	July.	August.	September.	October.	November.	December.
1870	....	....	....	....	583.560	583.260
1871	583.920	584.820	583.980	583.610	583.000	582.980
1872	583.670	584.020	583.990	583.720	583.610	583.680
1873	584.210	584.620	584.530	584.450	584.020	583.870
1874	584.130	584.470	584.570	584.310	584.190	583.970
1875	584.270	584.390	584.610	584.120	584.270	584.120
1876	585.640	585.850	585.700	585.070	585.120	585.060
1877	584.330	584.650	584.280	584.190	583.820	583.830
1878	584.140	583.890	583.730	583.770	583.070	583.250
1879	582.870	583.070	582.920	582.970	582.320	582.470
1880	583.970	583.980	583.910	583.550	583.010	583.370
1881	583.880	583.870	583.890	584.290	584.300	583.660
1882	584.140	584.400	584.170	584.000	582.970	583.418
1883	584.188	583.968	584.148	583.998	583.848	583.898
1884	583.938	583.978	584.018	584.198	583.878	583.868
1885	583.878	583.908	584.408	584.118	583.988	583.648
1886	584.558	584.438	584.228	584.248	583.646	583.626
1887	583.976	583.936	583.616	583.286	583.176	582.776
1888	583.487	583.077	583.147	583.557	583.167	583.167
1889	582.967	583.667	583.597	583.017	582.517	582.177
1890	583.327	583.467	583.467	582.967	582.757	582.367
1891	582.557	582.647	582.057	582.227	581.997	581.667
1892	582.807	582.867	582.687	582.397	581.707	581.577
1893	582.897	581.997	582.467	582.547	582.327	582.067
1894	583.027	582.987	582.857	582.697	582.567	582.287
1895	582.247	582.367	582.327	582.197	581.807	581.627
1896	582.427	582.667	582.427	581.917	581.767	581.767
1897	582.527	582.917	582.747	582.447	582.007	581.767
1898	582.567	582.467	582.517	582.137	581.967	581.867
1899	582.817	583.187	583.087	582.847	582.517	582.367
1900	582.077	582.467	582.767	583.087	582.867	582.458

Mean elevation of the surface of St. Marys River, below the locks, above mean tide at New York, for each calendar month, as determined from the daily noon observations.

Date.	January.	February.	March.	April.	May.	June.
1870	....	....	....	....	....	....
1871	584.262	584.255	584.197	583.810	584.229	584.445
1872	583.880	583.703	583.759	583.365	583.285	583.684
1873	585.103	585.543	585.230	584.313	583.687	584.063
1874	586.044	585.268	585.095	584.472	583.785	584.141
1875	586.345	585.883	585.889	584.919	583.958	584.331
1876	584.917	584.911	585.357	585.186	584.952	585.465
1877	585.287	584.777	584.601	584.283	584.134	584.334
1878	583.977	583.771	583.547	583.515	583.793	584.063
1879	584.295	583.661	583.524	582.935	582.699	582.822
1880	583.141	583.300	583.275	582.792	583.123	583.876
1881	584.289	584.879	584.358	583.613	583.553	583.871
1882	584.709	584.506	584.240	583.776	583.744	584.022
1883	584.523	584.607	584.588	583.835	583.556	584.073
1884	584.062	584.126	584.427	583.718	583.920	584.091
1885	584.920	585.513	585.389	584.870	584.379	584.492
1886	584.282	584.849	584.469	584.470	584.474	584.602
1887	583.906	583.941	584.025	584.017	583.891	584.016
1888	583.357	583.358	583.641	583.757	583.498	583.845
1889	583.764	583.574	583.424	582.742	583.001	583.394
1890	583.989	583.557	583.473	582.854	582.727	583.182
1891	583.095	583.104	583.010	582.737	582.590	582.543
1892	582.518	582.465	582.475	581.794	582.087	582.530
1893	581.985	582.061	582.157	582.108	582.259	582.879
1894	582.653	582.615	582.789	582.391	582.870	583.071
1895	583.163	583.560	583.073	582.261	582.012	582.280
1896	582.881	582.959	582.627	582.190	582.105	582.513
1897	582.790	582.629	582.631	581.726	582.188	582.591
1898	582.374	582.547	582.177	581.695	581.982	582.356
1899	582.773	582.809	582.879	582.381	582.813	582.844
1900	583.262	583.637	583.349	582.193	582.068	582.166
Monthly means for above period.	583.885	583.845	583.456	583.290	583.227	583.551

Mean elevation of the surface of St. Marys River, below the locks, etc.—Continued.

Date.	July.	August.	September.	October.	November.	December.	Annual means.
1870	....	....	....	....	....	583.867	....
1871	584.700	584.595	584.276	583.978	583.442	584.088	584.186
1872	583.914	584.152	584.270	584.110	584.000	584.527	583.883
1873	584.483	584.743	584.747	584.761	584.425	584.309	584.617
1874	584.407	584.648	584.659	584.616	584.381	584.446	584.664
1875	584.466	584.666	584.806	584.680	584.616	584.954	584.959
1876	585.910	586.037	585.906	585.543	585.234	586.189	585.467
1877	584.673	584.753	584.506	584.459	584.217	584.122	584.512
1878	584.237	584.129	583.941	584.024	583.517	583.731	583.854
1879	583.138	583.249	583.160	583.125	582.848	582.990	583.204
1880	584.245	584.159	584.121	584.082	583.941	584.205	583.688
1881	584.063	584.049	584.170	584.491	584.556	584.161	584.129
1882	584.396	584.532	584.472	584.276	584.063	583.922	584.221
1883	584.546	584.707	584.539	584.333	584.167	584.074	584.296
1884	584.117	584.190	584.271	584.477	584.239	584.130	584.147
1885	584.670	584.768	584.824	584.543	584.268	584.013	584.718
1886	584.664	584.573	584.539	584.466	584.220	583.987	584.425
1887	584.278	584.190	583.983	583.795	583.350	583.148	583.878
1888	583.846	583.826	583.934	583.916	583.642	583.505	583.667
1889	583.707	583.817	583.814	583.427	582.946	582.679	583.357
1890	583.545	583.583	583.562	583.384	583.209	582.980	583.337
1891	582.760	582.792	582.616	582.516	582.354	582.209	582.694
1892	583.002	583.118	583.081	582.706	582.251	581.814	582.488
1893	583.088	582.925	582.814	582.820	582.720	582.507	582.526
1894	583.176	583.131	583.022	582.928	582.828	582.598	582.838
1895	582.417	582.529	582.640	582.655	582.029	581.894	582.543
1896	582.700	582.852	582.713	582.258	582.148	582.062	582.500
1897	582.996	583.178	582.968	582.680	582.358	582.142	582.573
1898	582.715	582.761	582.666	582.474	582.334	582.261	582.362
1899	583.206	583.350	583.376	583.036	582.807	582.742	582.876
1900	582.548	582.887	583.310	583.385	583.228	582.956	582.915
Monthly means for above period.	583.820	583.896	583.857	583.731	583.478	583.457	....

Mean difference of elevation of the surface of St. Marys River at head of canal and below the locks, as determined from the daily noon observations.

Date.	January.	February.	March.	April.	May.	June.
1870	....	....	....	....	....	....
1871	16.903	16.747	16.541	17.059	17.217	17.411
1872	17.068	17.161	16.869	17.215	18.184	18.013
1873	16.182	15.566	15.908	16.839	18.022	17.782
1874	15.427	16.046	16.110	16.612	17.716	17.789
1875	15.351	15.565	15.518	16.738	18.003	17.936
1876	16.727	16.681	15.980	16.187	17.145	17.211
1877	16.548	17.083	17.145	17.338	17.491	17.514
1878	17.496	17.444	17.567	17.588	17.580	17.567
1879	16.530	16.764	16.658	17.876	17.986	18.002
1880	17.187	16.993	16.924	17.425	17.834	17.838
1881	16.910	16.726	16.768	17.398	17.884	17.794
1882	16.780	16.765	16.914	17.327	17.770	17.586
1883	16.622	16.442	16.468	17.288	17.562	17.412
1884	17.069	16.814	16.427	16.966	17.135	17.059
1885	16.327	15.622	15.609	15.952	17.027	17.249
1886	16.722	16.490	16.377	16.352	16.827	16.865
1887	17.039	16.861	16.748	16.614	17.104	17.427
1888	17.575	17.236	17.004	16.878	17.738	18.240
1889	17.564	17.464	17.636	18.313	18.615	18.401
1890	17.296	17.173	17.250	17.803	18.398	18.522
1891	17.567	17.669	17.617	18.064	18.641	18.637
1892	18.297	17.992	17.802	18.635	18.903	18.770
1893	18.604	18.340	18.248	18.541	18.966	18.878
1894	18.382	18.336	18.052	18.887	19.834	19.373
1895	18.638	18.105	18.391	19.182	19.838	19.953
1896	18.612	18.528	18.661	19.179	19.881	19.883
1897	18.932	18.786	18.800	19.841	19.722	19.679
1898	18,808	18.409	18.626	19.238	19.239	19.280
1899	18.560	18.368	18.188	18.680	19.606	19.523
1900	18.615	18.149	18.260	19.481	19.748	19.609
Monthly means for above period.	17.344	17.211	17.502	17.698	18.237	18.240

Mean difference of elevation of the surface of St. Marys River at head of canal, etc.—Cont'd.

Date.	July.	August.	September.	October.	November.	December.	Annual means.
1870	....	....	....	....	....	17.718	....
1871	17.335	17.359	17.729	17.827	18.141	17.152	17.285
1872	18.127	18.215	18.160	18.174	18.137	17.155	17.706
1873	17.805	17.793	17.851	17.719	17.834	17.718	17.252
1874	17.900	17.716	17.689	17.861	17.876	17.704	17.203
1875	17.880	17.697	17.837	17.832	17.617	16.718	17.058
1876	17.235	17.154	17.322	17.347	17.378	15.937	16.859
1877	17.504	17.536	17.549	17.633	17.638	17.567	17.379
1878	17.504	17.570	17.477	17.502	17.927	17.491	17.559
1879	17.986	17.908	17.915	17.974	18.073	17.533	17.558
1880	17.711	17.676	17.870	17.685	17.850	17.312	17.525
1881	17.805	17.739	17.799	17.946	17.778	17.847	17.533
1882	17.556	17.525	17.518	17.630	17.777	17.651	17.400
1883	17.115	17.381	17.213	17.275	17.322	17.155	17.105
1884	17.255	17.227	17.213	17.092	17.438	17.283	17.081
1885	17.249	17.378	17.080	17.178	17.381	17.340	16.783
1886	16.968	17.205	17.095	17.196	17.378	17.175	16.887
1887	17.535	17.506	17.572	17.934	18.150	17.947	17.370
1888	18.396	18.411	18.222	18.224	18.299	18.097	17.860
1889	18.356	18.253	18.249	18.489	18.671	18.550	18.213
1890	18.520	18.391	18.301	18.412	18.447	18.375	18.074
1891	18.532	18.512	18.622	18.778	18.831	18.661	18.344
1892	18.438	18.333	18.428	18.694	18.872	19.027	18.516
1893	18.864	19.111	19.092	19.027	19.072	18.749	18.791
1894	19.406	19.460	19.487	19.573	19.579	19.508	19.106
1895	20.052	19.958	20.018	20.122	20.227	20.154	19.553
1896	19.828	19.693	19.698	19.733	19.867	19.889	19.454
1897	19.502	19.481	19.520	19.591	19.809	19.534	19.433
1898	19.259	19.325	19.557	19.594	19.563	19.549	19.204
1899	19.361	19.368	19.529	19.585	19.806	19.711	19.186
1900	19.493	19.358	19.419	19.469	19.651	19.494	19.225
Monthly means for above period.	18.216	18.208	18.233	18.301	18.413	18.119	....

The commerce passing through the St. Marys River, as shown by the accurate statistics of traffic through both the Canadian and American locks at the Sault for the navigable season of 1900, a period of 238 days, was 25,643,073 tons of freight, valued at $267,041,959. The number of passengers reported in transit through the locks was 58,555.

The unexpended balance of previous appropriations is sufficient to complete all work contemplated by the present approved project of improvement, and for this reason no further appropriation is now needed for this purpose.

The work is in the collection district of Superior, Mich. The nearest port of entry is Marquette, but Sault Ste. Marie is a subport. The nearest light-houses are the beacons on the western end of the canal, and Fort Brady is within a mile.

Total expenditure to June 30, 1900	$3,933,013.81
Expended during fiscal year, excluding outstanding liabilities	36,416.24
Total expenditure to June 30, 1901	3,969,430.05

Money statement.

July 1, 1900, balance unexpended	$830,890.75
June 30, 1901, amount expended during fiscal year	36,416.24
July 1, 1901, balance unexpended	794,474.51
July 1, 1901, outstanding liabilities	7,616.61
July 1, 1901, balance available	[1] 786,857.90

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[1] Includes $500 reserved for expenses office Chief of Engineers.

Appropriations for improving St. Marys River, Michigan.

August 5, 1886	$250,000.00
August 11, 1888	1,000,000.00
September 19, 1890	900,000.00
March 3, 1891, sundry civil act	600,000.00
March 3, 1893, sundry civil act	1,230,000.00
August 18, 1894, sundry civil act	300,000.00
March 2, 1895, sundry civil act	483,865.00
Total	4,763,865.00
Receipts from sales of fuel to officers, January, May, and June, 1887	26.63
Repayment of disallowance of part voucher 19, August, 1894 (see p. 2895, Report Chief of Engineers, 1894)	12.13
Repayment of disallowance of part voucher 24, September, 1896	.80
	4,763,904.56

REPORT OF MR. JOSEPH RIPLEY, ASSISTANT ENGINEER.

United States Engineer Office,
Sault Ste. Marie, Mich., July 1, 1901.

Colonel: I have the honor to submit the following report of operations for improving St. Marys River, Michigan, during the fiscal year ending June 30, 1901:

The outer 240 feet of the northeast pier extension was completed in September, a much needed improvement and one that has been of great benefit to all boats passing through the Poe lock.

The boat-house dock was extended parallel to the northeast pier for a distance of 170 feet, making its total length 240 feet, and thus providing for a safe and convenient harbor for the Government tugs and scows.

New designs were made for the stone and glass buildings to shelter the gate engines on Poe lock. Three of them, about 19 feet square and 10 feet high, were erected last fall by John B. Irwin for $650 each. The contractor furnished all the material and labor, except cutting the stone, which was done by the United States. The last two shelters are being built by M. N. Hunt for $690 each. The buildings protect the engines from dirt and rain, and also provide shelter for the lockmen when they are not busy locking boats.

The concrete sidewalks on south side of canal were finished; 1,462 square yards were laid. On the north side of the canal 3,200 square yards of walks 5 feet wide and 6 inches deep were made of limestone chips which were raked and rolled, then surfaced with a thin layer of cement and sand.

The canal grounds were further improved by setting out 950 trees and shrubs.

Preliminary studies were made for designing a suitable movable dam to stop flow of water through canal in case of lock gates being swept out.

Two accidents occurred whereby sunken boats nearly blockaded the channel. The schooner *Maida* struck the rocks on west bank of American channel at Sailors Encampment, and shut off all but 75 feet of the width of the channel from 4 p. m., August 14, to 10.30 a. m., August 18. The steamer *Colonial* was sunk in the channel above Little Rapids from 6.15 a. m., October 23, to 9 a. m., October 28.

The River and Harbor Congressional Committee, on their inspection trip around the Great Lakes, passed here twice, upbound on August 12 and returned on August 19. The chairman, Hon. T. E. Burton, and other members of the committee carefully examined and considered the maps, plans, and estimates in connection with the several localities to be improved.

The sweeping for shoals with suspended bars from the raft was continued during favorable weather throughout the season, and has progressed so that the examination now covers the full width of the natural and improved channels of the river from Point Iroquois to Detour, including both the Lake George and Hay Lake routes, except a reach of 12 miles long in the vicinity of Lime Island. The contours between 20 and 28 feet depth of water were accurately located, and those shoals which may be a possible menace to navigation developed with soundings.

The particulars as to surveys for widening the canal, for correcting charts, and for improving the Lake George Channel are reported by Assistant Engineer Rohnert, as follows:

Examination by suspended raft bars.—The examination of St. Marys River, via Lake George and extending from the upper to the lower entrance to Hay Lake Channel, was begun on September 10 and finished November 24. Its purpose was to ascertain the condition of the improved and natural channel ways and to locate and develop any additional shoals that might be found.

Shoal 17, which is situated at the upper end of the Catholic Mission range course through Little Lake George, was found to have a small ridge projecting above the improved grade about 0.2 of a foot. It is about 200 feet long and lies between south channel line and one 30 feet north thereof.

Shoal 18, at the lower end of the Catholic Mission range course, showed a filling in along the north channel line. The length is 1,250 feet and width about 50 feet. The highest part projects about 1.2 feet above the the improved grade and lies along the toe of slope.

Considerable silting was found in the Lake George cut. It was principally in the form of ridges and occurred close to the north and south channel lines. On the Duck Island ranges, at lower end of the cut and where no improvements had been made, a flat, averaging 40 feet wide and 3,000 feet long, was found, on which the least depth of water was 14.8 feet.

The entire reach of the Hen and Chicken range course, from 75 feet north to 150 feet south, was clear at a depth of 16 feet. For a length of 2,000 feet, and from 75 to 150 feet north, the bank gradually rose to a least depth of 13.5 feet. The line of the ranges does not coincide with the center line of the improved channel.

The work was reported on in detail during the several months it was in progress.

Ten bench marks were established, 23 channel-line equations obtained, and rectangular coordinates of and azimuths to 270 marker buoys computed. The buoys were set from triangulation stations, of which 45 were occupied.

Removal of bowlders from shoals 7 to 15.—Public notice dated July 13, 1900; Hickler Brothers, of Sault Ste. Marie, Mich., contractors. Rate for services of diver and crew, together with derrick scow, $4.80 per working hour. Rate for services of attending tug and crew, $2 per working hour.

After the examination with raft bars, it was evident that at a small expense the depth of water over shoals 7 to 15, lying in the channel via Lake George, could be increased from 1½ to 2 feet. The removal of the stones and bowlders from the shoals was begun on November 3 and finished on the 16th. The diving outfit worked 96¾ hours and was delayed 27 hours. The tug in attendance worked 101 hours. All the material, excepting 2 cubic yards, was placed in the adjoining deep water.

Extension of northeast pier to Poe lock.—Under public notice dated July 13, 1900, the diving outfit of Hickler Brothers was used in transferring heavy bowlders from Canadian dump to fill cribs 5 and 6 of the northeast-pier extension. Between August 7 and 16 525 cubic yards were handled. The plant was worked 99¾ hours and was delayed 1 hour.

Surveys.—A survey for a proposed widening of the St. Marys Falls Canal above the locks and to the northward was completed in December. There were 27 stakes set and 6,609 level pointings recorded. The levels were reduced and plotted.

The following additions to Chart No. 3 of St. Marys River were located: The line of the Algoma Central Railroad for a distance of 3 miles; the dock constructed at Davignon Point; the track connecting old with the new Union Depot at Sault Ste. Marie, Mich.; several stone piles projecting above the water's surface, and the new ferry dock at Sault Ste. Marie, Ontario. All notes were plotted on a copy of the chart and transmitted.

General.—Observations were taken to determine the velocity of current at the movable dam through St. Marys Falls Canal during the filling of Poe and Weitzel locks.

A dumping ground was buoyed out for the use of the Lake Superior Water Power Company. Its location was immediately north of the Topsail Island ranges.

A spike, which it has been customary to drive into the south pier near the movable dam and from which daily gauge readings were taken during the winter season of 1900–1901, was placed and read in. Its elevation was 604.498 feet above mean tide water at New York.

Quarters boats *Hay Lake* and *Swallow*, tugs *Myra* and *Antelope*, stake-driver scow, and sweeping raft were laid up for the winter season and again fitted out in the spring.

Very respectfully, your obedient servant,

JOSEPH RIPLEY,
Assistant Engineer.

Col. G. J. LYDECKER,
Corps of Engineers, U. S. A.

P P 3.

OPERATING AND CARE OF ST. MARYS FALLS CANAL, MICHIGAN.

This service is provided for from the permanent indefinite appropriation for operating and care of canals and other works of navigation under section 4 of the river and harbor act of July 5, 1884.

The canal was in service two hundred and thirty-one days, the closed period of one hundred and thirty-four days being December 13, 1900, to April 26, 1901. The number of lockages made during the fiscal year was 8,875, by which 14,975 vessels of 18,345,306 tons registry passed to and from Lake Superior with 20,994,320 tons of freight and 35,327 passengers. The number of lockages through the Canadian canal during the same period was 2,409, passing 3,531 vessels of 2,464,052 tons registry, with 2,742,392 tons of freight and 26,900 passengers. The total Lake Superior traffic was therefore represented by the passage of 18,506 vessels, carrying 23,736,712 tons of freight and 62,227 passengers. This, as compared with the previous fiscal year is a decrease of 12 per cent in the number of vessel passages, of 2 per cent in the number of lockages, and of 14 per cent in freight tonnage; and an increase of 22 per cent in passenger traffic.

The canal post-office handled 99,390 pieces of mail, consisting of 89,252 letters, 5,060 postal cards, 4,517 newspapers, and 561 packages. Six hundred and sixty-eight pieces were returned to the city post-office after being held thirty days, and 1,947 pieces were forwarded to new addresses.

The total delays that occurred in locking vessels during the year amounted to 282½ hours, of which 239½ related to the Poe lock and 43 to the Weitzel lock. The principal lost time in the former was June 9–16, 1901, when 172 hours were lost, the lock being pumped out in order to make extensive repairs to gates, miter sills, platform, and hollow quoins on account of damage done by the steamer *W. R. Linn;* and 30½ hours November 13–14, when lock was pumped out to repack valve engines and substitute oil for water in the pressure system. The Weitzel lock was out of service 25½ hours for the same purpose November 16–17. All other delays, aggregating 53½ hours, were due to minor mishaps to lock machinery, tow lines fouling in propellers, sunken logs, and fenders against miter sills, and broken gate cables.

No accident resulting in any material damage to the canal or locks occurred during the year until the night of June 3, 1901, when the steamer *W. R. Linn*, upbound, struck the lower gate of the Poe lock; the lock was full at the time, yet the force of the blow was such as to break the miter of the gates and press the south leaf several feet upstream against a water head of about 20 feet. Fortunately the gates remitered almost instantly and thereby averted a disaster of the gravest possible nature. The principal damage resulting from the collision was as follows: Six vertical steel plates in south leaf of lower gates were deeply dented and many rivets sheared off, six interior horizontal frames were buckled, and the angle frames bent. The curvature of the north leaf was increased about 6 inches as a result of the momentary strain to which it was subjected while not in miter with the south leaf; the miter-sill was torn loose for a length of 60 feet, and the platform against which it abuts, and which extends 37 feet downstream, was displaced through a distance of from 1½ to 3½ inches; the oak cushion pieces on face of miter posts were splintered and crushed and the angle of quoin stones of the gate recesses were broken all the way from floor of lock up to within 5 feet of the top of the lock walls. Temporary repairs were made which it is believed will enable the lower gates to continue in use during the rest of the season of navigation, but extensive permanent repairs will then be necessary. The accident appears to have been due primarily to bad management of the vessel's master when coming alongside of the pier, and then to some misunderstanding between him and his engineer which resulted in sending the vessel ahead instead of backing.

During the period of suspended navigation—December to April—both locks, including all operating machinery, were overhauled and put in complete repair. The work was of the usual routine character, though somewhat more extensive than in previous years.

The regular lock-operating and canal force consisted of 81 men, including those in charge of canal office and records, property, and grounds, viz: One superintendent, 1 chief engineman, 3 assistant superintendents, 2 clerks, 11 watchmen, 6 lock masters, 6 enginemen, 9 first-grade lockmen, 9 second-grade lockmen, 15 third-grade lockmen, and 18 linemen. In addition to this general force there was a labor party, varying in numbers from 15 to 30, as needed for care and repair of the canal piers and grounds.

Copy of report prepared by Mr. Joseph Ripley, assistant engineer and general superintendent of the canal, is submitted herewith.

The estimated amount required for the year ending June 30, 1902, is $110,000, to be applied, approximately, as follows: For pay rolls, $65,000; for repairs, $30,000; for general supplies, $7,000; for electric lighting buildings, locks, and grounds, $3,000, and for office expenses and general contingencies, $5,000.

St. Marys Falls Canal is in the collection district of Superior, Mich. The nearest port of entry is Marquette, but Sault Ste. Marie is a subport. Two beacons stand upon the piers at the western end of the canal and Fort Brady is within a mile.

Summary of expenditures for operating and care of St. Marys Falls Canal, Michigan, for the fiscal year ending June 30, 1901.

Services (personal)	$62,529.88
Materials[1]	3,441.67
Supplies	5,630.96
Electric lighting	2,265.68
Office contingencies (fuel, stationery, etc.)	1,607.14
Total	75,475.33

Money statement.

Expended to June 30, 1900		$886,202.76
Outstanding liabilities June 30, 1900		7,095.45
Total expenditures to June 30, 1900		893,298.21
Expended during fiscal year ending June 30, 1901	$75,559.34	
Deduct outstanding liabilities pertaining to preceding year	7,095.45	
	68,463.89	
Add outstanding liabilities June 30, 1901	7,011.44	
		75,475.33
Total expenditures to June 30, 1901 (including outstanding liabilities)		968,773.54

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[1] Includes shopwork and other nonpersonal sevices.

Estimate.

Amount (estimated) for fiscal year ending June 30, 1902	$110,000
Balance from allotment for preceding year (estimated)	15,000
Additional allotment required for fiscal year ending June 30, 1902	95,000

Expenditures for operating and care of St. Marys Falls Canal, Michigan.

1882	$31,207.48	1893	$42,412.12
1883	35,509.70	1894	55,213.09
1884	31,212.93	1895	50,908.67
1885	27,242.45	1896	60,763.28
1886	25,400.95	1897	78,104.05
1887	22,138.92	1898	58,890.72
1888	29,898.72	1899	90,307.94
1889	30,749.45	1900	79,293.26
1890	34,323.85	1901	75,475.33
1891	48,330.89		
1892	61,389.74	Total	968,773.54

Statement of receipts and expenditures for fiscal year ending June 30, 1901.

Receipts:	
Balance at close of fiscal year ending June 30, 1900 (including outstanding liabilities)	$5,706.74
July 30, 1900 (allotted)	85,000.00
Total	90,706.74
Expenditures	75,475.33
Balance at close of fiscal year ending June 30, 1901	15,231.41

COMMERCIAL STATISTICS.

Statistics of commerce passing through the American and Canadian canals at Sault Ste. Marie, Michigan and Ontario, during the season of 1900.

[Compiled from official records.]

The traffic for season of 1900 exceeds that of any previous year, yet the percentage of increase was the smallest for the past ten years, the falling off being in the last half of the season.

Compared with 1899 there were nearly 32,000,000 bushels less of wheat and other grain, also one-third of a million tons less of anthracite coal. The increased tonnage was principally on the one item of iron ore.

While the larger boats carried a greater percentage of the total freight, yet the increase in the number of boats less than 300 feet long was only three less than the number over 300 feet long, being 22 and 25, respectively.

The total freight traffic of 25,643,073 net tons is the maximum traffic in the history of the canals. It exceeds the traffic of 1899 by 387,263 tons, or 2 per cent. The total number of passengers was 58,555, an increase of 9,473, or 19 per cent. The season of navigation was open for a period of seven months and twenty-eight days, during which time the average monthly freight traffic was 3,232,320 tons.

The American canal passed 23,607,354 freight tons, being an increase of 1,355,215 net tons over the year 1899, or 6 per cent; the number of passengers was 36,313, an increase of 2,649, or 8 per cent, as compared with 1899.

The Canadian canal passed 2,035,719 freight tons, which was a decrease of 967,952 net tons, or 32 per cent. The number of passengers was 22,242, an increase of 6,824, or 44 per cent, as compared with 1899.

Of the total freight the American canal passed 92 per cent and 62 per cent of the total number of passengers; the Canadian canal 8 per cent and 38 per cent, respectively.

The total vessel passages through both canals numbered 19,452, as against 20,255 for the year 1899, a decrease of 803, or 4 per cent; the total lockages numbered 10,685, which is 314 less than 1899, or a decrease of 3 per cent.

The United States canal was opened April 19 and closed December 12, 1900; season, two hundred and thirty-eight days. The Canadian canal was opened April 23 and closed December 16, 1900; season, two hundred and thirty-eight days.

Freight tonnage and passengers.—The data relative to these items were compiled from reports made by the vessel masters when passing through the American and Canadian locks, a daily exchange of these reports being made.

Registered tonnage and vessel valuations.—The net registered tonnage is given and was obtained from vessel papers and blue books. Vessel valuations were obtained from Inland Lloyds.

Freight rates.—These were compiled from quotations published in the Marine Review and Marine Record, and from information obtained from shippers, owners, and carriers engaged in handling the several classes of lake commerce. The freight rates given are for transportation, and include cost of loading and unloading.

Freight valuations.—The unit values used for the various items of freight were derived by taking the mean for the season of each monthly average as obtained from daily or weekly prices current.

The sources of valuations given are as follows: Coal, quotations in Coal Trade Journal at Duluth and Superior; cereals, Daily Commercial Record, published by the Duluth board of trade; flour, daily quotations in Duluth, Superior, and Minneapolis journals; iron ore and pig iron, weekly quotations in Iron Trade Review, Marine Record and Marine Review; salt, quotations at Lake Superior ports; copper, general merchandise, lumber, building stone, and manufactured iron, quotations by the principal shippers, owners, and carriers.

To quotations given at point of shipment freight rates are added to lake ports of destination.

Statistical statement showing east and west bound commerce passing canals at Sault Ste. Marie, Michigan and Ontario, for the season of 1900.

EAST BOUND.

Items.	United States canal.	Canadian canal.	Total.
Copper … net tons	126,671	4,395	131,066
Grain … bushels	15,042,161	1,022,064	16,064,225
Building stone … net tons	43,912	4,990	48,902
Flour … barrels	6,123,246	631,630	6,754,876
Iron ore … net tons	15,439,617	1,003,951	16,443,568
Iron, pig … do	19,985	90	20,075
Lumber … M feet B. M.	898,093	11,558	909,651
Silver ore … net tons	110	…………	110
Wheat … bushels	31,325,693	9,163,609	40,489,302
General merchandise … net tons	65,875	20,458	86,333
Passengers … number	16,965	12,233	29,198

WEST BOUND.

Items.	United States canal.	Canadian canal.	Total.
Coal:			
Hard … net tons	476,181	39,334	515,515
Soft … do	3,488,558	482,904	3,971,462
Flour … barrels	212	5,600	5,812
Grain … bushels	26,084	84,350	110,434
Manufactured iron … net tons	97,101	18,409	115,510
Salt … barrels	318,358	10,537	328,895
General merchandise … net tons	394,885	60,179	455,064
Passengers … number	19,348	10,009	29,357
Freight:			
East bound … net tons	19,102,494	1,429,999	20,532,493
West bound … do	4,504,860	605,720	5,110,580
Total freight … do	23,607,354	2,035,719	25,643,073
Vessel passages … number	16,369	3,083	19,452
Registered tonnage … net tons	20,136,782	2,179,052	22,315,834

NOTE.—In addition to the above traffic 15,500 cords pulp wood and 8,500,000 feet pine logs passed over the rapids, bound for lower lake ports.

Table showing freight tonnage for each calendar month during season of 1900.

Month.	East bound.	West bound.	Total freight.
	Net tons.	*Net tons.*	*Net tons.*
April	305,678	167,804	473,482
May	3,267,550	824,847	4,092,397
June	3,252,216	855,386	4,107,602
July	3,244,358	857,407	4,101,765
August	2,986,272	728,502	3,714,774
September	2,825,011	586,442	3,411,453
October	2,675,894	513,399	3,189,293
November	1,674,903	504,869	2,179,772
December	300,611	71,924	372,535
Total	20,532,493	5,110,580	25,643,073

Table showing lake ports from and to which the east and west bound freight was transported.

EAST BOUND.

From Lake Superior ports to—	Net tons.
Lake Michigan ports	2,054,819
Lake Huron ports	659,405
Lake Erie ports	17,604,773
Lake Ontario ports	213,496
Total	20,532,493

WEST BOUND.

From lower lake ports to Lake Superior—	
Lake Michigan ports	73,841
Lake Huron ports	130,333
Lake Erie ports	4,890,938
Lake Ontario ports	15,468
Total	5,110,580

Comparative statement of lake commerce through United States and Canadian canals at Sault Ste. Marie, Michigan and Ontario, for the seasons of 1899 and 1900.

Items.	Traffic for 1900.		Total traffic for—		Increase (+) or decrease (—), 1900.	
	United States canal.	Canadian canal.	Season 1900.	Season 1899.	Amount.	Per cent.
Vessel passages:						
Steamers .... number..	11,805	2,621	14,426	14,378	+ 48	0
Sails .... do....	3,701	303	4,004	4,776	— 772	16
Unregistered .... do....	863	159	1,022	1,101	— 79	7
Total .... do....	16,369	3,083	19,452	20,255	— 803	4
Lockages .... do....	8,479	2,206	10,685	10,999	— 314	3
Tonnage:						
Registered .... net tons..	20,136,782	2,179,052	22,315,834	21,958,347	+ 357,487	2
Freight .... do....	23,607,354	2,035,719	25,643,073	25,255,810	+ 387,263	2
Passengers .... number..	36,313	22,242	58,555	49,082	+ 9,473	19
Coal:						
Hard .... net tons..	476,131	39,384	515,515	841,281	— 325,766	39
Soft .... do....	3,488,558	482,904	3,971,462	3,099,606	+ 871,856	28
Flour .... barrels..	6,123,458	637,230	6,760,688	7,114,147	— 353,459	5
Wheat .... bushels..	31,325,693	9,163,609	40,489,302	58,397,335	—17,908,033	31
Grain, other than wheat. do....	15,068,245	1,106,414	16,174,659	30,000,935	—13,826,276	46
Manufactured and pig iron, net tons	117,086	18,499	135,585	214,585	— 79,000	37
Salt .... barrels..	318,358	10,537	328,895	316,336	+ 12,559	4
Copper .... net tons..	126,671	4,395	131,066	120,090	+ 10,976	9
Iron ore .... do....	15,439,617	1,003,951	16,443,568	15,328,240	+ 1,115,328	7
Lumber .... M feet B. M..	898,093	11,558	909,651	1,038,057	— 128,406	12
Silver ore .... net tons..	110	....	110	487	— 377	77
Building stone .... do....	43,912	4,990	48,902	39,063	+ 9,839	25
General merchandise ... do....	460,760	80,637	541,397	587,484	— 46,087	8

Estimated value of freight passing St. Marys Falls Canal, Michigan, and Sault Ste. Marie Canal, Ontario, for the season of 1900.

Items.		Quantity.	Price per unit.	Valuation.
Coal:				
Anthracite	net tons	515,515	$5.25	$2,706,454
Bituminous	do	3,971,462	3.00	11,914,386
Flour	barrels	6,760,688	4.00	27,042,752
Wheat	bushels	40,489,302	.70	28,342,511
Grain, other than wheat	do	16,174,659	.87	14,071,958
Manufactured iron	net tons	115,510	100.00	11,551,000
Pig iron	do	20,075	17.50	351,318
Salt	barrels	328,895	1.00	328,895
Copper (refined and matte)	net tons	131,066	300.00	39,319,800
Iron ore	do	16,443,568	3.75	61,663,380
Lumber	M feet B. M	909,651	16.50	15,009,241
Silver ore	net tons	110	125.00	13,750
Building stone	do	48,902	12.00	586,824
General merchandise	do	541,397	100.00	54,139,700
Total				267,041,959

Average value per ton of freight for season of 1900, $10.41.
Average value per ton of freight for season of 1899, $11.14.

Comparative statement of freight valuations for the seasons of 1899 and 1900.

Articles.	1899.	1900.	Increase (+) or decrease (−).
Coal:			
Anthracite	$5.70	$5.25	−$0.45
Bituminous	2.60	3.00	+ .40
Flour	3.60	4.00	+ .40
Wheat	.75	.70	− .05
Grain, other than wheat	.59	.87	+ .28
Manufactured iron	100.00	100.00	
Pig iron	19.50	17.50	− 2.00
Salt	.75	1.00	+ .25
Copper (refined and matte)	320.00	300.00	−20.00
Iron ore	3.40	3.75	+ .35
Lumber	17.00	16.50	− .50
Silver ore	125.00	125.00	
Building stone	12.00	12.00	
General merchandise	90.00	100.00	+10.00

Value of grain, other than wheat.

Articles.	Bushels.	Price per unit.	Total value.
Rye	882,414	$0.52	$459,131.97
Oats	1,390,540	.24	337,098.62
Corn	3,985,768	.38½	1,534,820.65
Barley	3,923,886	.44	1,732,189.84
Flax	5,992,051	1.69	10,077,047.44
Total	16,174,659		14,140,288.52

Average value, 87 cents.

The relative values of the different commodities are as follows:

	Per cent.
Coal (anthracite and bituminous)	5.5
Cereals (wheat, rye, oats, corn, barley, flax, and flour)	26
Iron (iron ore, manufactured, and pig iron)	27.6
Copper	14.7
Lumber	5.6
All other products	20.6

Cost of carrying freight transported through St. Marys Falls Canal, Michigan, and Sault Ste. Marie Canal, Ontario, for the season of 1900.

Articles.		Quantity.	Rate per unit.	Amount.
Coal	net tons	4,486,977	$0.44	$1,974,269.88
Flour	barrels	6,760,688	.12	811,282.56
Wheat	bushels	40,489,302	.02	809,786.04
Grain (other than wheat)	do	16,174,659	.02	323,493.18
Manufactured iron	net tons	115,510	2.00	231,020.00
Pig iron	do	20,075	1.50	30,112.50
Salt	barrels	328,895	.15	49,334.25
Copper	net tons	131,066	1.60	209,705.60
Iron ore	do	16,443,568	1.05	17,265,746.40
Lumber	M ft. B. M	909,651	2.30	2,092,197.30
Silver ore	net tons	110	2.00	220.00
Building stone	do	48,902	1.50	73,353.00
General merchandise	do	541,397	2.00	1,082,794.00
Total				24,953,314.71

Comparative statement of freight rates to and from Lake Superior for the seasons of 1899 and 1900.

Articles.		Average cost per unit.	
		1899.	1900.
Coal	net tons	$0.46	$0.44
Flour	barrels	.13	.12
Wheat	bushels	.036	.02
Grain (other than wheat)	do	.036	.02
Manufactured iron	net tons	1.70	2.00
Pig iron	do	1.50	1.50
Salt	barrels	.15	.15
Copper	net tons	2.00	1.60
Iron ore	do	.70	1.05
Lumber	M ft. B. M	3.00	2.30
Silver ore	net tons	2.50	2.00
Building stone	do	2.00	1.50
General merchandise	do	2.50	2.00

Total cost of transportation, 1899, $21,959,707.25.
Total cost of transportation, 1900, $24,953,314.71.

Table showing total freight, its valuation, cost of transportation, average length of trips, and rate per ton per mile for seasons indicated.

Year.	Total freight.	Valuation of freight.	Total cost of transportation.	Average distance freight was carried.	Cost of transportation per mile-ton.
	Net tons.			*Miles.*	*Mills.*
1887	5,494,649	$79,031,757	$10,075,153.13	811.4	2.8
1888	6,411,423	82,156,019	7,883,077.40	806.4	1.5
1889	7,516,022	83,732,527	8,634,246.63	790.4	1.5
1890	9,041,213	102,214,948	9,472,214.90	797.2	1.3
1891	8,888,759	128,178,208	9,849,022.81	820.4	1.35
1892	11,214,333	135,117,267	12,072,850.88	822.4	1.31
1893	10,796,572	145,436,957	9,957,483.11	831.9	1.1
1894	13,195,860	143,114,502	10,798,310.28	821.1	.99
1895	15,062,580	159,575,129	14,238,758.02	830	1.14
1896	16,239,061	195,146,842	13,511,615.80	836.4	.99
1897	18,982,755	218,235,927	13,220,099.84	841.3	.83
1898	21,234,664	233,069,740	14,125,896.00	842.6	.79
1899	25,255,810	281,364,750	21,959,707.25	827.2	1.05
1900	25,643,073	267,041,959	24,953,314.71	825.9	1.18

Classification of American and Canadian vessels, showing tonnage and passengers carried by each of them through canals at Sault Ste. Marie, Mich., and Ontario during season of 1900.

AMERICAN VESSELS.

Class.	Number.	Valuation.	Tonnage.		Passengers.
			Registered.	Freight.	
Steamers	515	$54,172,989	637,847	18,940,603	24,789
Sailing	296	1,943,594	281,816	5,909,383	....
Unregistered	....	....	....	46,237	....
Total	811	66,116,583	919,163	24,896,223	24,789

CANADIAN VESSELS.

Class.	Number.	Valuation.	Registered.	Freight.	Passengers.
Steamers	54	$3,365,856	28,617	646,147	33,766
Sailing	14	252,720	7,467	89,801	....
Unregistered	....	....	....	10,902	....
Total	68	3,618,576	36,084	746,850	33,766

American vessels carried 97 per cent of the total freight and 42 per cent of the total passengers.

Canadian vessels carried 3 per cent of the total freight and 58 per cent of the total passengers.

Unregistered American crafts carried 46,237 tons of freight in 364 passages, or an average of 127$\frac{48}{2000}$ tons per passage.

Unregistered Canadian crafts carried 10,902 tons of freight in 90 passages, or an average of 121$\frac{267}{2000}$ tons per passage.

Of the 19,452 passages for the season, 3,674 were by 88 vessels under 100 tons register, or an average of 31 tons each. The total freight carried by such craft amounted to 1,351 tons.

Table showing classification of registered vessels as to the length and beam over all.

Length.	Beam.	Number of vessels.
Up to 100 feet	Between 6 and 24 feet	82
Between 100 and 200 feet	Between 22 and 38 feet	320
Between 200 and 300 feet	Between 30 and 42 feet	285
Between 300 and 400 feet	Between 38 and 48 feet	136
Between 400 and 500 feet	Between 45 and 53 feet	56

Classifications of vessels based on largest single cargo carried by each boat when same exceeded 2,000 tons, arranged in successive graduations of each thousand tons.

Class.	Number.	Maximum tonnage for one trip.	
		Aggregate.	Average.
Steamers	87	222,097	2,553
Do	110	374,268	3,403
Do	14	61,879	4,420
Do	18	97,262	5,403
Do	20	128,723	6,436
Do	19	142,154	7,482
Do	5	41,170	8,234
Sailing	30	73,389	2,446
Do	15	50,626	3,375
Do	9	39,909	4,434
Do	18	102,925	5,718
Do	5	33,228	6,646
Do	4	30,211	7,553
Do	3	24,334	8,111

The above table shows that 357 different vessels in a single trip of each carried a total of 1,422,175 net tons.

Table showing maximum records made by vessels during the season.

Name of vessel.	Maximum.	Amount.	Owners.
Steamer John W. Gates	Single cargo, tons	8,462	American Steamship Co.
Barge Madeira	do	8,206	Minnesota Steamship Co.
Steamer Presque Isle	Freight carried, tons	195,550	Cleveland Cliffs Iron Co.
Steamer Troy	Miles run	45,318	New York Central and Hudson R. R. Co.
Steamer John W. Gates	Mile-tons	154,554,378	American Steamship Co.

The maximum traffic for a single day was on June 4, when 219,364 freight tons were passed by 125 vessels, whose registered tonnage amounted to 171,707.

The minimum traffic for a single day was on December 15, when 2 freight tons were passed by 4 vessels, whose registered tonnage amounted to 124 tons.

MISCELLANEOUS.

The depth of water in the St. Marys River permitted a safe draft of about 18 feet during the season.

The American canal records show that vessels necessarily spent 19,366 hours and 33 minutes in canal, or an average of 1 hour 10 minutes and 59 seconds, which includes time waiting for lockage and passage through locks and canal, the latter being 1⅗ miles long. Other delays at canal, which included taking on supplies, waiting for daylight or favorable weather, amounted to 16,298 hours and 31 minutes.

The railway swing bridge across the canal has not delayed the passage of vessels in a single instance, but the total delays to trains amounted to 56 minutes, by passing boats temporarily preventing the closing of the bridge.

The canal post-office delivered 104,587 pieces of mail during the season, consisting of 93,689 letters, 5,406 postals, 4,898 newspapers, and 594 parcels. In addition to this, 674 pieces were returned to the city post-office after being held 30 days uncalled for, and 2,052 pieces were forwarded to new addresses. This shows an increase over the previous year of 7,209 pieces of mail.

GENERAL SUMMARY.

Statistical summary of lake commerce through canals at Sault Ste. Marie, Michigan and Ontario, for season of 1900.

Total mile-tons	21,179,229,014
Total freight carried ....net tons..	25,643,073
Total valuation placed on freight carried	$267,041,959
Average value per ton of freight carried	$10.41
Total amount paid for freight transportation	$24,953,314.71
Average distance freight was carried ....miles..	825.9
Cost per mile per ton ....mills..	1.18
Average cost per ton for freight transportation	$0.97
Total number registered vessels using canals	879
Total number of passages by unregistered craft carrying freight	454
Time American lock was operated ....days..	238
Time Canadian lock was operated ....do....	238
Total valuation placed on registered vessels	$69,735,159
Total number of passengers transported	58,555
Freight carried by—	
Registered vessels ....tons..	25,585,934
Unregistered vessels ....do....	57,139
American vessels ....per cent..	97
Canadian vessels ....do....	3
Passengers carried by—	
American vessels ....do....	42
Canadian vessels ....do....	58

REPORT OF MR. JOSEPH RIPLEY, ASSISTANT ENGINEER AND GENERAL SUPERINTENDENT.

UNITED STATES ENGINEER OFFICE,
Sault Ste. Marie, Mich., July 1, 1901.

COLONEL: I have the honor to submit the following report relative to operating and care of St. Marys Falls Canal, Michigan, for the fiscal year ending June 30, 1901:

ORGANIZATION.

The regular force of 83 persons, viz, 1 general superintendent, 1 superintendent, 2 clerks, 1 chief engineman, 3 assistant superintendents, 6 lock masters, 6 enginemen, 1 suboverseer, 11 watchmen, 9 first-grade lockmen, 9 second-grade lockmen, 15 third-grade lockmen, and 18 linemen were employed in locking boats, office work, and care of property.

An average number of 17 laborers were employed 7½ months in repairing piers, care of grounds, etc.

Carpenters, painters, and stonecutters were employed whenever their services were required.

There were nine changes in personnel of employees due to resignation or discharge.

REPAIRS.

The fitting out and maintenance repairs were made as usual.

The general repairs to the machinery were more extensive and thorough than heretofore, and were made during the winter season with a force of twelve men. In addition to renewing all worn or broken parts of the turbines, pumps, accumulators, gate and valve engines, the six gate engines on Poe lock were taken apart and phosphor-bronze bushings put in the 32 planet gears.

The 12 valves in culverts were raised from frames and rebushed; also, their cover plates were rebolted with larger bolts to old and new frames.

The bed plates of valve engines were rebolted to well floors.

Fifteen additional openings, about 3 by 4 feet in size, were cut through the timber walls between culverts in Poe lock, which make eight openings now, with an aggregate area of 100 square feet, through each partition wall.

About 50 of the vertical rods were tightened. There will be no further movement in the lock floor till the vibration of the bolts wears out the nut threads.

As it was almost impossible to keep the 4-inch brass pumps in steel gates in working order, they were all removed and pipes placed for siphoning with compressed air.

The broken hollow quoin stones of south intermediate gate recess, extending from lock floor for a height of 39 feet, were replaced with concrete. Similar repairs were made for 16 feet of quoin stones of southwest gate of Weitzel lock. The pressure pipe along south wall of Weitzel lock was renewed for the first time in twenty years.

The roof of the canal office building was painted and storm sash made for the windows.

Six new poles were erected to extend system of arc lights out to ends of northeast and southwest piers.

Temporary repairs were made to lock gates, stone hollow quoins, miter sill, and its reinforcing platform, which were damaged by the steamer *Wm. R. Linn*, up bound, striking the lower gates of the Poe lock on June 3, 1901.

ACCIDENTS.

There were two fatal and three other accidents in the canal, resulting in loss of limbs, by sailors getting caught in bight of snubbing or tow lines.

There were about twenty accidents whereby the locks, piers, or vessels were damaged. The most serious one was the striking of the southeast gate, 6 feet from miter post, on night of June 3, by the up-bound steamer *Wm. R. Linn*, when the lock was full and the upper gates were about one-third open. The miter of the gates was broken at least 2 feet at bottom and 4 feet at top. The curvature of the north gate was increased about 6 inches. Sixty feet of the miter sill was torn loose and the timber platform, 37 feet deep back of miter sill, was moved from 1½ to 3½ inches downstream. The oak cushions on miter posts of gates were splintered and crushed, and the hollow quoin stones of gate recesses were broken and cracked from bottom of lock to within 5 feet of coping.

Six of the vertical steel plates in south gate were deeply dented and many of the rivets sheared off; also, six of the interior horizontal plates were buckled and the angle frames bent. Permanent repairs can not be made till next winter. The intermediate gates were used till June 25. Since then the lower gates have been in commission.

The possibility of the accident started while the boat was making a landing alongside the northeast pier, by the chief engineer starting the engine ahead while he thought that it was backing. Then the captain made the mistake of repeating the backing signal many times instead of first stopping the engine. The steamer was light, otherwise both the lower and upper gates would have been swept out.

DELAYS.

The total delays to navigation at the Poe lock amounted to $239\frac{47}{60}$ hours, of which $29\frac{28}{60}$ hours was due to failure of lock machinery, $2\frac{27}{60}$ hours to fouling of towing lines, $2\frac{50}{60}$ hours to rope fenders and logs against miter sills, $2\frac{18}{60}$ hours to accidents aboard boats, $30\frac{40}{60}$ hours (November 13 and 14) pumping out lock to repack the valve engines and fill the pressure pipes with oil, and $172\frac{4}{60}$ hours (June 9–16) pumping out lock to repair gates, miter sill, platforms, and masonry damaged by steamer *Wm. R. Linn.*

The Weitzel lock was delayed a total of $42\frac{50}{60}$ hours, of which 3 hours was due to broken gate cables and failure of machinery, $1\frac{30}{60}$ hours to fouling of tow lines, $\frac{40}{60}$ hour to log against miter sill, 1 hour to boat with too deep a draft trying to enter lock, 11 hours to rating of current meter, and $25\frac{40}{60}$ hours (November 16 and 17) to pumping out lock to repack valve engines and fill pressure pipes with oil.

MISCELLANEOUS.

Among the special reports prepared the most important one was the statistics of commerce passing through the canals during the season of 1900, which was submitted January 31.

Other reports related to accidents resulting in damage to canal, with bills for repairs against steamers *Sir Henry Bessemer*, *Cornell*, *Wm. R. Linn*, *Maunaloa*, *Arthur Orr*, *Saturn*, *Senator*, and *Tampico;* schooners *Manila* and *David Z. Norton;* widening slip adjacent to Fort Brady pier for revenue cutter, with estimate of cost; methods of procedure in laying up locks for winter season; list of employees, position, salary, and years of service; charges and investigations; extreme high water, storm of December 8; specifications and drawings for new valve engines, 12-inch cylinders, to replace the present engines with 8-inch cylinders; specifications for supplies, timber, etc.

The worn-out and broken property was inspected by Col. Simon Snyder on September 13, who condemned it for sale or to be destroyed.

The following traffic statements were prepared by clerks McArthur and McMahon:

Statistical report of lake commerce through canals at Sault Ste. Marie, Michigan and Ontario, for the fiscal year ending June 30, 1901.

Items.		United States canal.	Canadian canal.	Total.
Vessel passages	number	14,975	3,531	18,506
Lockages	do	8,875	2,409	11,284
Registered tonnage	net tons	18,345,306	2,464,052	20,809,358
Freight tonnage	do	20,994,320	2,742,392	23,736,712
Passengers	number	35,327	26,900	62,227
Coal, hard	net tons	444,885	38,401	483,286
Coal, soft	do	3,001,918	529,354	3,531,272
Flour	barrels	5,913,871	869,264	6,783,135
Wheat	bushels	23,809,512	6,915,742	30,725,254
Grain, other than wheat	do	14,227,036	2,079,864	16,306,900
Manufactured and pig iron	net tons	93,920	30,584	124,504
Salt	barrels	388,086	19,345	407,431
Copper	net tons	104,824	8,558	113,382
Iron ore	do	13,662,474	1,640,341	15,302,815
Lumber	M.ft.B.M	891,058	15,397	906,455
Silver ore	net tons	110	....	110
Building stone	do	46,838	6,150	52,988
General merchandise	do	443,421	96,312	539,733

NOTE.—The United States canal was open to navigation 231 days during the fiscal year. The Canadian canal was open to navigation 241 days during the fiscal year.

Comparative statement of commerce through St. Marys Falls Canal, Michigan, for the fiscal years 1900 and 1901.

Items.	Fiscal year.		Increase.	Decrease.
	1900.	1901.		
Vessel passages ....number..	17,524	14,975	....	2,549
Lockages ....do.....	9,033	8,875	....	158
Tonnage, registered ....net tons..	20,807,873	18,345,306	....	2,462,567
Tonnage, freight ....do.....	24,554,559	20,994,320	....	3,560,239
Passengers ....number..	34,976	35,327	351	....
Coal ....net tons..	3,919,721	3,446,803	....	472,918
Flour ....barrels..	6 415,246	5,913,871	....	501,375
Wheat ....bushels..	49,974,388	23,809,512	....	26,164,876
Grain, other than wheat ....do.....	21,946,813	14,227,036	....	7,719,777
Manufactured and pig iron ....net tons..	211,303	93,920	....	117,383
Salt ....barrels..	243,672	388,086	144,414	....
Copper ....net tons..	132,991	104,824	....	28,167
Iron ore ....do.....	15,297,903	13,662,474	....	1,635,429
Lumber ....M. ft. B. M..	1,021,012	891,058	....	129,954
Silver ore ....net tons..	487	110	....	377
Building stone ....do.....	42,888	46,838	3,950	....
General merchandise ....do.....	510,054	443,421	....	66,633

Summary of traffic through St. Marys Falls Canal, Michigan, for the fiscal year ending June 30, 1901.

Number of vessels through Weitzel lock	6,956
Number of vessels through Poe lock	8,019
Number of lockages through Weitzel lock	3,987
Number of lockages through Poe lock	4,888
Total registered tonnage	18,345,306
Total freight tonnage	20,994,320
Total time occupied in making lockages	3,570 hrs. 35 min.
Average time occupied in making a lockage	24 min. 14 sec.
Total time spent by vessels in passing locks	8,322 hrs. 38 min.
Average time spent by vessels in passing locks	33 min. 34 sec.
Cost per lockage	$8.60
Cost per passage	$5.10
Cost per registered ton	4.16 mills
Cost per freight ton	3.64 mills

The Weitzel lock was open to navigation two hundred and eleven days, from July 1 to December 4, 1900, and from May 8 to June 30, 1901.

The time for the Poe lock was two hundred and thirty-one days, July 1 to December 12, 1900, and from April 26 to June 30, 1901.

The commerce through St. Marys Falls Canal, Mich., shows a decrease, as compared with the previous fiscal year, in the following items: Vessel passages, 15 per cent; lockages, 2 per cent; registered tonnage, 12 per cent; freight tonnage, 14 per cent; coal, 12 per cent; flour, 8 per cent; wheat, 52 per cent; grain other than wheat, 35 per cent; manufactured and pig iron, 56 per cent; copper, 21 per cent; iron ore, 11 per cent; lumber, 13 per cent; silver ore, 77 per cent; general merchandise, 13 per cent. An increase is shown in the following items: Passengers, 1 per cent; salt, 59 per cent, and building stone, 11 per cent.

In comparing the total traffic through the American and Canadian canals at Sault Ste. Marie, Michigan and Ontario, with the previous fiscal year it shows a decrease as follows: Vessel passages, 12 per cent; lockages, 2 per cent; registered tonnage, 12 per cent; freight tonnage, 14 per cent, and an increase of 22 per cent in the number of passengers carried.

The falling off in traffic during the past fiscal year was due, in large measure, to depression in freight rates during the first half of fiscal year, to late opening of navigation caused by the St. Clair River ice blockades, and to the vessel enginemen's strike.

The canal post-office delivered 99,390 pieces of mail during the fiscal year, consisting of 89,252 letters, 5,060 postals, 4,517 newspapers, and 561 parcels. In addition to this 668 pieces were returned to the city post-office after being held 30 days uncalled for, and 1,947 pieces were forwarded to new addresses.

The traffic for June of 4,519,075 tons of freight was the largest for any one month in the history of the canal, and exceeds the previous maximum record by 411,473 tons.

Very respectfully, your obedient servant,

JOSEPH RIPLEY,
Assistant Engineer and General Superintendent.

Col. G. J. LYDECKER,
Corps of Engineers, U. S. A.

P P 4.

IMPROVEMENT OF HAY LAKE CHANNEL, ST. MARYS RIVER, MICHIGAN.

This improvement was commenced in 1883 and opened to navigation June 7, 1894. The result was a new line of travel through the St. Marys River, 11 miles shorter and 4 feet deeper than that previously available and one which can be navigated at night with a reasonable degree of safety. The width of channel was 300 feet and the general navigable depth 20 feet; but the first step in the work had been in rock cutting through the Middle Neebish section, and there the bottom grade was about 2 feet higher than in the other parts of the improvement. Work since 1895 has been applied to increasing the width of channel at critical points, to the removal of some isolated shoals that have been discovered in the meantime, and to making the depth through the Middle Neebish section equal to that of the other portions of the improved channel.

At the beginning of the last fiscal year the dredged portion of the Hay Lake Channel was about 10 miles long, 6 of which has a width of 300 feet and the remaining 4 a width of from 450 to 1,100 feet. The depth was 20 feet in soft-bottom sections and 21 feet where rock or stone exists.

Operations during the last fiscal year were confined to extensive surveys related to projected improvements and to reenforcing the Middle Neebish dike by placing about 2,300 cubic yards of bowlders along its exposed face to save it from the wash of current and swells of passing boats. These operations and other matters of interest are described in the following extract from a report prepared by Mr. Benno Rohnert, assistant engineer, who had immediate supervision of the work:

Reenforcement of Middle Neebish dike.—Public notice dated July 13, 1900; Hickler Brothers, of Sault Ste. Marie, Mich., contractors. Rate for services of diver and crew, together with derrick scow, $4.80 per working hour. Rate for services of attending tug and crew, $2 per working hour.

After a public notice dated May 16, 1899, there had been 2,300 cubic yards of bowlders placed along the water's edge on the south side of and in the open gaps of the Middle Neebish dike, whose destruction was threatened by the wash of the waves of passing boats. The completion of the work was interrupted on account of lack of funds. Operations were resumed on August 18, after public notice dated July 13, 1900, and continued until November 1. The diver's outfit raised 2,414 cubic yards of bowlders in 628¾ hours with a delay of 72¼ hours. The bowlders were taken from the dredge coamings on the north and south sides of the existing channel. A total length of 6,200 feet has been reenforced. The tug in attendance worked 645¾ hours. Five pounds of dynamite were used in blasting bowlders.

Surveys.—On February 13 a two-auger ice-survey party left Sault Ste. Marie for Charlotte River camp. A detailed survey was made of course 5, West Neebish channel, and also its angles with courses 4 and 6. There were 127 stakes set from six triangulation stations and 27,976 soundings taken. The party broke camp on March 4. The entire West Neebish channel had been surveyed in detail except that part of course 6 which passes through the rapids.

A survey was also made at the upper entrance to Hay Lake channel. The shoal above the light-house was developed by 1,453 soundings. From stations 14 and 23 18 cross-section stakes were set.

A line of levels was run between bench marks P and L at Little Rapids to determine the elevations of nine intermediate ones.

Computations.—The project called for by the act of Congress of March 3, 1899, for a safe and convenient channel 21 feet deep between Lakes Superior and Huron, necessitated the computation of the volume of a large amount of material. Duplicate computations have been made for some of the reaches and compared with the original ones. The following are such:

Widening of channel through Little Rapids Islands.

Excavation of courses 4, 5, 7, and 8 and part of course 6, proposed West Neebish channel.

Approximate amounts of material have been computed for the following:

Widening of Middle Neebish channel.
Widening and deepening of foot of Hay Lake cut.
Deepening Waldo and Nine Mile Point shoals.
Deepening section 4, 20 and 21 feet channel.
Deepening in front of Fort Brady pier.
Deepening Spry shoal.
Deepening shoals at upper end of course 4, West Neebish channel.
Deepening channel through Little Rapids Islands.

The azimuths to 144 stakes from adjacent triangulation stations were computed for use in surveying course 5, West Neebish channel; also to 34 stakes to be used in widening the Little Rapids cut.

Plotting of soundings.—The soundings of the following surveys have been plotted on tracing linen:

Widening and deepening the channel at foot of Hay Lake.
Widening and deepening the channel through Little Mud Lake.
Widening channel abreast of Sailors Encampment Island.
Deepening Waldo and Nine Mile Point shoals.
Deepening shoals along Point of Woods course.
Deepening shoals at upper end of course 4, West Neebish channel, course 5, West Neebish channel, and its angles with courses 4 and 6.
Widening at Bayfield shoal.

This plotting required the reduction of about 145,000 soundings.

The plotting of the soundings of courses 4, 5, 6, 7, and 8, West Neebish channel, on cross-section sheets has been begun.

General.—In October the upper entrance to Hay Lake channel above and abreast of the light-house was swept with raft bars suspended at 20 feet to locate a bowlder that had been reported as projecting above grade. The entrance was found clear.

The center-line profile of the proposed West Neebish channel was plotted. It shows the character of the material in the channel bed to a depth of 30 feet below mean water's surface.

The red spar buoy marking the lower course of the angle at the foot of Hay Lake was found out of position and correctly placed.

Specifications have been completed and proposals are about to be invited for increasing the width of channel in the Little Rapids section from 300 to 600 feet, in accordance with project submitted May 18, 1900, and approved June 28, 1900. The proposed improvement will pass through Island No. 1, most of which was owned by private parties until December 24, 1900, when their interests were duly transferred to the United States in consideration of payment of $12,000, made April 3, 1901. This transfer completes the United States title to all of the island except a small plot at its southwest corner, which lies about 100 feet westward of the west channel bank and is not likely to be required in connection with any future improvement. The work about to be commenced will be prosecuted under continuing contracts, as provided by the river and harbor act of March 3, 1899, wherein a total expenditure of $494,115 was authorized. The sum of $350,000 has already been appropriated for this purpose, and the remaining $144,115 should be supplied by the next sundry civil act to meet obligations that will be incurred under the proposed continuing contracts.

Under date of June 4, 1900, a report was submitted (and printed as

Doc. 128, Fifty-sixth Congress, second session), which contains projects and estimates for such improvement "between Lakes Superior and Huron, including Hay Lake channel, as will secure a safe and convenient channel 21 feet deep." The last Congress fully recognized the urgent necessity of such an improvement by an item in the river and harbor bill considered at its second session, which authorized continuing contract expenditures aggregating $4,500,000 for that purpose. Though the bill failed to pass, it seems probable that the next Congress may take favorable action in the matter, and such action is highly important to the vast commerce that is deeply interested in the earliest possible completion of the proposed improvement.

Money statement.

July 1, 1900, balance unexpended	$350,000.00
June 30, 1901, amount expended during fiscal year	46,905.78
July 1, 1901, balance unexpended	303,094.22
July 1, 1901, outstanding liabilities	1,176.23
July 1, 1901, balance available	301,917.99
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	144,115.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

Appropriations for improving Hay Lake Channel, St. Marys River, Michigan.

August 2, 1882	$200,000.00
July 5, 1884	125,000.00
August 5, 1886	150,000.00
August 11, 1888	500,000.00
September 19, 1890	400,000.00
March 3, 1891 (sundry civil act)	300,000.00
August 5, 1892 (sundry civil act)	115,000.00
March 3, 1893 (sundry civil act)	225,000.00
August 18, 1894 (sundry civil act)	150,000.00
March 3, 1899	100,000.00
June 6, 1900 (sundry civil act)	250,000.00
Total	2,515,000.00
Receipts from sales of fuel to officers between March, 1883, and March, 1887	124.90
Repayment of disallowance, voucher 9, November, 1885 (see p. 2245, Report of Chief of Engineers, 1887)	6.75
Repayment of disallowance, part of voucher 8, August, 1894 (see p. 3052, Report of Chief of Engineers, 1895)	10.82
	2,515,142.47

COMMERCIAL STATISTICS.

Table showing extent and growth of commerce through Hay Lake channel, as derived from official records of St. Marys Falls canals, Michigan and Ontario.

Season of navigation.	Freight.	Valuation.	Passengers.
1894	13,195,860	$143,114,502	27,236
1895	15,062,580	159,575,129	31,656
1896	16,239,061	195,146,842	37,066
1897	18,982,755	218,235,927	40,213
1898	21,234,664	233,069,789	43,426
1899	25,255,810	281,364,750	51,050
1900	25,648,073	267,041,959	58,555

P P 5.

IMPROVEMENT OF ST. CLAIR FLATS CANAL, MICHIGAN.

The history of this improvement to June 30, 1896, is outlined in the Report of the Chief of Engineers for that year, pages 2881–2889, and no work has been done since then.

The total expenditure to June 30, 1901, was $761,750.61.

The amount of commerce that passes through this canal annually is substantially the same as that passing through the Detroit River, and this is estimated at about 42,000,000 freight tons for the last calendar year.

The emergency river and harbor act of June 6, 1900, called for plan and estimate for doubling the present commercial capacity of the canal, as respects width of channel, and the required reports dated July 28 and December 6, 1900, were duly submitted to Congress; they were published in House Doc. No. 234, Fifty-sixth Congress, second session. The river and harbor bill (H. R. 13189) that was considered at that session contained an item appropriating the whole amount required to carry out the project presented in the reports, and this item was agreed to by both Houses of Congress, but the session ended before final action could be had on the bill.

The combined freight and passenger traffic through this canal is as great as that at any other point on the lake, yet the width of channel now available is about 40 feet less than when the canal was opened to navigation in 1871, thirty years ago; for each ton of freight then passing through the canal we now have at least 14 and possibly 15. For these, and other reasons indicated in the reports previously referred to, it is respectfully urged that the next Congress make ample appropriation for providing the required increase in width.

St. Clair Flats Canal is in the collection district of Detroit, Mich. The nearest port of entry is Detroit. Two light-houses stand upon its banks.

Money statement.

July 1, 1900, balance unexpended	$3,059.39
July 1, 1901, balance unexpended	[1]3,059.39

Appropriations for improving St. Clair Flats Canal, Michigan.

June 23, 1866	$80,000	June 18, 1878	$5,000
March 2, 1867	150,000	March 3, 1879	3,000
July 25, 1868	86,000	June 14, 1880	2,500
April 10, 1869	142,560	August 5, 1886	18,750
July 11, 1870	16,500	August 11, 1888	75,000
March 3, 1871	1,500	September 19, 1890	80,000
June 10, 1872	4,000		
March 3, 1873	100,000	Total	764,810

NOTE.—The appropriations of 1852, $20,000, and 1856, $45,000, are not taken account of, for the reason that they did not enter into the improvement of St. Clair Flats Canal, the first having been expended in building a dredge and the second in dredging the North Channel of the South Pass. From March 3, 1881, the amounts allotted for operating and care of St. Clair Flats Canal are rendered separately.

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[1] Includes $500 reserved for expenses Office Chief of Engineers.

P P 6.

OPERATING AND CARE OF ST. CLAIR FLATS CANAL, MICHIGAN.

This service is provided for by the permanent indefinite appropriation for operating and care of canals and other works of navigation under section 4 of the river and harbor act of July 5, 1884.

During the last fiscal year the routine work of watching traffic through the canal and reading water gauges was carried on as usual. The pile revetment of dikes was slightly damaged on several occasions by passing vessels, and the necessary repairs were made. Other minor repairs were made, such as securing loose revetment timbers or plank, and the trees on the dikes were trimmed.

No record of commerce passing through the canal is kept, but it is substantially the same as that of the Detroit River, whose freight traffic during the year 1900 is estimated at about 42,000,000 tons.

The canal is in the collection district of Detroit, Mich. Two lighthouses stand upon its banks.

Summary of expenditures for operating and care of St. Clair Flats Canal, Michigan, for the fiscal year ending June 30, 1901.

Services (personal)	$2,042.58
Materials[1]	975.56
Office contingencies (telegrams, telephone, fuel, and laundry)	35.09
Total	3,053.23

Money statement.

Expended to June 30, 1900		$81,918.36
Expended during fiscal year ending June 30, 1901	$2,860.23	
Outstanding liabilities June 30, 1901	193.00	
		3,053.23
Total expenditures to June 30, 1901 (including outstanding liabilities)		84,971.59

Expenditures for operating and care of St. Clair Flats Canal, Michigan.

1882	$8,786.69	1893	$2,675.93
1883	5,668.87	1894	3,592.18
1884	2,532.15	1895	1,993.32
1885	4,906.59	1896	2,501.57
1886	9,539.11	1897	2,162.81
1887	1,819.53	1898	2,099.65
1888	1,510.00	1899	2,399.78
1889	20,315.00	1900	3,348.15
1890	2,158.16	1901	3,053.23
1891	2,020.20		
1892	1,888.67	Total	84,971.59

Statement of receipts and expenditures for fiscal year ending June 30, 1901.

Receipts: Balance at close of fiscal year ending June 30, 1900	$39,813.04
Expenditures	3,053.23
Balance at close of fiscal year ending June 30, 1901	36,759.81

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[1] Includes "shop work" and other nonpersonal services.

P P 7.

IMPROVEMENT OF DETROIT RIVER, MICHIGAN.

This improvement was commenced in 1874 under a project for excavating a channel through a reef of limestone bed rock, known as the Limekiln Crossing, and operations have been continued since that time, resulting in the removal of the principal obstructions to navigation in the main channel of the river from its mouth to the foot of Fighting Island, a distance of about 12 miles; the work has consisted mainly in the removal of bed rock and extensive bowlder shoals over which the safe navigable depth, before improvement, varied from 12½ to 15 feet at mean stage of water. As a result, the work done to June 30, 1900, the safe navigable depth at that stage was increased to 18 feet at the shoalest parts of the channel, and to depths of from 19 to 21 feet through most of the distance. The width of the improved channel varies from 300 to 600 feet.

At the beginning of the last fiscal year operations had been inaugurated under the continuing contract system, as described in the Report of the Chief of Engineers for 1900, pages 3997–4001, and they were continued throughout the year, as follows:

1. *Limekiln Crossing.*—Under contract dated May 18, 1900, with J. B. Donnelly, of Buffalo, N. Y., to increase the width of the channel in that section to 600 feet by drilling, blasting, and dredging limestone bed rock, covering an area 180 feet wide and 3,000 feet long. The present average depth of water over this area is about 13 feet, and when work under the contract is completed the least depth will be 21 feet at ordinary low water. Operations were commenced June 23, and continued to December 14, 1900, when they were suspended for the winter. They were resumed April 10, 1901, and are still in progress. The total amount of rock dredged to June 30, 1901, was 20,198 cubic yards, bank measurement. As a preliminary to the work of dredging, the steam drills drove 13,367 blast holes, aggregating 104,056 feet in length, and 96,821 pounds of dynamite were used in blasting. The contract price for the work is $2.27 per cubic yard, bank measurement, for rock removed down to the required clear depth of 21 feet, and half that rate for such excess of excavation as is included between that grade and the depth of 23 feet. The total cost of this improvement will be about $175,000, and the contract calls for its completion by December 1, 1901.

2. *Ballards Reef.*—Under contract dated July 3, 1900, with the Buffalo Dredging Company, of Buffalo, N. Y., to deepen the west half of the 600-foot channel in this section to 21 feet at ordinary low water by drilling, blasting, and dredging bowlder shoals and bed rock. The area to be so improved under this contract is 300 feet wide and 8,500 feet long, and the least depth of water over it before the work was commenced was about 18 feet at mean stage of water. Operations were commenced August 9 and continued until December 14, 1900, when they were suspended for the winter. They were resumed April 19, 1901, and are still in progress. The total amount of material dredged to June 30, 1901, to the limit of depth for which the contractor

is entitled to compensation, was 32,346 cubic yards, bank measurement, of which 15,199 cubic yards lay above the depth of 22 feet and 17,147 between that grade and the depth of 23 feet. In advance of work by the dredges the steam drills made 28,130 blast holes, aggregating 113,867 feet in length, and 70,543 pounds of dynamite were used in blasts. The contract price is $2.65 per cubic yard, bank measurement, for excavation to the depth of 22 feet, and half that rate for material removed between the planes of 22 and 23 feet depths. The total cost of this improvement will be about $145,000, and the contract calls for its completion by December 1, 1901.

3. Under contract with M. Sullivan, of Detroit, Mich., dated July 6, 1900, for time work at the rate of $14.50 per hour, 21,891 cubic yards of clay, sand, stone, and bowlders were dredged in 1,209¼ hours, actual working time, between July 11 and December 4, 1900. The total cost was $17,532.91, or 80½ cents per cubic yard. The work covered an area of about 80,000 square yards, on which the least depth before improvement was 17.5 feet, and after it 21 feet, except at a few points where bed rock was encountered at a depth of 19 feet.

4. Under contract with E. J. Hingston, of Buffalo, N. Y., dated July 6, 1900, for time work at $10.25 per hour, a shoal near the south end of Fighting Island was removed between July 24 and August 15, 1900, by excavating 10,108 cubic yards of sand, clay, and small bowlders, in 225¼ hours actual working time; total cost $2,380.95, or at the rate of 23½ cents per cubic yard. This shoal was about 250 feet eastward of the regular sailing course for deep draft vessels, and covered an area of about 8,000 square yards; the least depth was 15 feet before improvement and 21 feet after it.

5. Under verbal agreement with J. B. Donnelly, of Buffalo, N. Y., his dredge was employed 295¼ hours between October 4 and December 4, 1900, at $9 per hour, in removing 10,175 cubic yards of sand, clay, gravel, and bowlders; total cost $2,657.25, or 26$\frac{1}{10}$ cents per cubic yard. This work was in the southerly approach to the Limekiln Crossing and covered an area of about 9,500 square yards, on which the least depth was 17 feet before improvement and 21 feet after it.

A plant comprising two derrick scows with diving outfits, one steam drill, a sweeping raft, and steam launch was operated by hired labor during most of the year for the purpose of removing bowlders and other obstructions from sections of the channel outside of the limits of contract work. In these operations 4,141 bowlders, measuring 2,040 cubic yards in all, were removed from the channel.

Work was also commenced under a contract with M. Sullivan, of Detroit, Mich., June 6, 1901, for improving the channel through Amherstburg Reach by dredging and rock excavation; at the close of the year 3,986 cubic yards of clay, sand, and bowlders had been removed, 276 blast holes aggregating 1,104 feet in length were drilled, and 1,182 pounds of dynamite used in blasts. The contract price is $2.90 per cubic yard, bank measurement, and the work is to be completed December 1, 1902, at a total cost of about $285,000.

Extensive hydrographic surveys relating to improvements in progress or projects for future work were made, in which 162,536 located soundings were recorded, 54,525 of which were taken through the ice; all have been duly reduced, platted, and traced.

Further interesting details concerning the operations outlined above are contained in the accompanying report, prepared by Assistant Engineer Chas. Y. Dixon, who is in immediate charge of the work.

By the river and harbor act of March 3, 1899, Congress authorized expenditures for this improvement to the amount of $661,500, to be paid from appropriations subsequent to that date, and the sundry civil acts of June 6, 1900, and March 3, 1901, have provided $525,000 for that purpose. The remaining $136,500 will be required to complete the work as contemplated by the present approved project, and it is recommended that this amount be appropriated by the next sundry civil act. About $50,000 of this amount will be required to meet obligations under existing contracts, including related engineering and office contingencies; and the remainder for work that is not provided for by these contracts, but which must be done before the entire channel can be cleared to a navigable depth of 20 feet at mean stage of water; this is especially the case in the Limekiln channel, where a clear depth of only 19 feet is found at a number of points.

A report dated May 29, 1900, containing plans and estimates for such further improvements "as will secure a safe and convenient channel 21 feet deep," was submitted to Congress at its last session, and the river and harbor bill considered at that session contained an item appropriating $500,000 and authorizing contracts for expending $1,250,000 more for that purpose. This item was agreed to in both Houses, but the bill eventually failed to pass, and it is now of profound importance to the vast commerce of the Great Lakes that the next Congress take favorable action in the matter. The report herein referred to is published in the Report of the Chief of Engineers for 1900, pages 4016–4018, and was also printed with map as House Doc. No. 712, Fifty-sixth Congress, first session.

A report on preliminary examination of the Grosse Isle Channel of the river, dated October 20, 1900, was also submitted, and printed as Document No. 82, Fifty-sixth Congress, second session.

The Detroit River is in the collection district of Detroit, Mich., which is the port of entry. There are six American and one Canadian light-houses between the head of the river and its mouth, including that on the adjoining bar in Lake Erie.

Money statement.

July 1, 1900, balance unexpended	$295,522.84
Amount appropriated by sundry civil act approved March 3, 1901	325,000.00
	620,522.84
June 30, 1901, amount expended during fiscal year	130,420.68
July 1, 1901, balance unexpended	490,102.16
July 1, 1901, outstanding liabilities	46,096.00
July 1, 1901, balance available	444,006.16
July 1, 1901, amount covered by uncompleted contracts	477,426.51
Amount (estimated) required for completion of existing project	136,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	136,500.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897.

Appropriations for improving Detroit River, Michigan.

June 23, 1874	$25,000.00	July 13, 1892	$30,000.00
June 18, 1878	100,000.00	August 18, 1894	30,000.00
March 3, 1879	50,000.00	June 3, 1896	30,000.00
June 14, 1880	50,000.00	March 3, 1899	100,000.00
March 3, 1881	50,000.00	June 6, 1900	200,000.00
August 2, 1882	60,000.00	March 3, 1901	325,000.00
July 5, 1884	200,000.00		
August 5, 1886	37,500.00	Total	1,418,000.00
August 11, 1888	130,500.00		

Receipts from sales of fuel to officers between October, 1884, and December, 1886	108.41
Repayment of disallowance voucher 4, November, 1885 (see p. 2268, Report Chief of Engineers, 1887)	2.00
	1,418,110.41

ABSTRACT OF CONTRACTS IN FORCE DURING THE FISCAL YEAR ENDING JUNE 30, 1901.

Contract dated May 18, 1900, for dredging Limekiln Crossing.

Name of contractor: James B. Donnelly, Buffalo, N. Y.
Rates: $2.27 per cubic yard, bank measurement (full rate), and $1.13½ per cubic yard, bank measurement (half rate).
Date of approval: June 4, 1900.
Date of commencement: June 23, 1900.
Date of completion: December 1, 1901.

Contract dated July 3, 1900, for dredging Ballards Reef channel.

Name of contractor: The Buffalo Dredging Company, Buffalo, N. Y.
Rates: $2.65 per cubic yard, bank measurement (full rate), and $1.32½ per cubic yard, bank measurement (half rate).
Date of approval: July 30, 1900.
Date of commencement: August 9, 1900.
Date of completion: December 1, 1901.

Contract dated July 6, 1900, for time work by dredging plant.

Name of contractor: Edward J. Hingston, Buffalo, N. Y.
Rate: $10.25 per hour.
Date of approval: July 24, 1900.
Date of commencement: July 24, 1900.
Date of completion: August 15, 1900.

Contract dated July 6, 1900, for time work by dredging plant.

Name of contractor: M. Sullivan, Detroit, Mich.
Rate: $14.50 per hour.
Date of approval: August 3, 1900.
Date of commencement: July 11, 1900.
Date of completion: December 4, 1900.

Contract dated June 6, 1901, for dredging Amherstburg Reach.

Name of contractor: M. Sullivan.
Rate: $2.90 per cubic yard, bank measurement.
Date of approval: June 27, 1901.
Date of commencement: June 4, 1901.
Date of completion: December 1, 1902.

COMMERCIAL STATISTICS.

No accurate record of the commerce of the Detroit River is obtainable; but from data contained in custom-house records of the upper and lower lake ports, reports of boards of trade or similar commercial bodies, and summaries published by the Bureau of Statistics of the Treasury Department, it is estimated that not less than 42,000,000 tons of freight were carried through the river during the calendar year 1900.

REPORT OF MR. CHAS. Y. DIXON, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Amherstburg, Ontario, July 1, 1901.

COLONEL: I have the honor to submit the following report of operations under my charge, during the fiscal year ending June 30, 1901, connected with the improvement of the Detroit River.

Improvement near the south end of Fighting Island.—The object of this improvement was to secure a channel depth of 21 feet for a width of 600 feet (300 feet each side of the sailing line). The area improved was about 8,000 square yards, being 1,200 feet long and of an average width of 60 feet, situated along the east channel line. The south end of this area is 1,300 feet north from the intersection of the Grosse Isle south channel and the Grosse Isle north channel ranges. The average depth of water prior to improvement was about 18.5 feet, and the least depth about 15 feet. The material removed consisted of clay and sand, with a few small bowlders. This work was performed by Edward J. Hingston, of Buffalo, N. Y., under formal contract dated July 6, 1900, for furnishing and operating a dredging plant on the basis of "time work"—the contract price being $10.25 per hour. This improvement was commenced July 24, 1900, and completed August 15, 1900. The number of hours worked by the dredge was 225¼, and the amount of material removed was 10,108 cubic yards, scow measurement. This work was performed at a cost to the United States of $2,380.75, being 23½ cents per cubic yard, scow measurement.

Item A.—Ballards Reef Channel.—The object of this improvement is the deepening to 21 feet of the west 300 feet of a 600-foot channel along the Grosse Isle south channel range. The length of channel covered by this improvement is about 8,500 feet, and the least depth prior to improvement was about 18.5 feet. This work is being performed by the Buffalo Dredging Company, of Buffalo, N. Y., under formal contract dated July 3, 1900. The contract price is $2.65 per cubic yard, bank measurement, and the maximum cost of this improvement is $141,112.50. The plant in use consists of two dredges, one steam-drill boat equipped with three drills, one steam-drill boat equipped with two drills, two tugs, and the necessary dump scows. Work under this contract was commenced on August 9, 1900, and was continued until December 14, 1900, when the season's operations ceased. Dredging operations were resumed on April 19, 1901, by one dredge, and by the second dredge on May 14, 1901. The contract expires December 1, 1901, but it is improbable that the work will be completed by that time.

The amount of material removed during the fiscal year was 15,199 cubic yards above 22 feet depth at full contract rate, and 17,147 cubic yards between 22 and 23 feet depths at half of the contract rate. The amount earned by the contractor was $62,997.13.

The material being removed consists of limestone bed rock, large buried bowlders, loose stones, clay, and sand. Over the greater part of the area improved it has been found necessary to do drilling and blasting before the material may be removed. The holes were drilled at the corners of 5-foot squares, the number of hours worked by the drills was 6,667, and the number of holes drilled was 28,130, being 113,867 linear feet. The number of pounds of dynamite used was 70,543.

Regarding the working season as extending from May 1 to December 1, the contract has been in force two hundred and one days, this being 57 per cent of the total time until the expiration of the contract. During this time the contractors have earned about 45 per cent of the total amount which may be earned under this contract, and have improved about 35 per cent of the total area. Work with diver and derrick scow is still necessary, however, in order to secure the required depth within the area thus far improved.

Section 2. Lime Kiln crossing.—The object of this improvement is the deepening to 21 feet of an area 180 feet wide to the west of the present improved channel at Lime Kiln crossing, the width of the channel when completed being 600 feet. The length of channel covered by this contract is about 3,000 feet, and the least depth prior to improvement was about 14 feet. This work is being performed by James B. Donnelly, of Buffalo, N. Y., under formal contract dated May 18, 1900. The contract price for this work is $2.27 per cubic yard, bank measurement, and the maximum cost of the improvement is $172,520. The work under this contract was commenced on June 23, 1900, by the use of a steam drill, and on August 8, 1900, by the use of a dredge, and was continued until December 14, 1900, when the season's operations ceased. Work was resumed on April 10, 1901, by the use of a steam drill. A second steam drill has also been used since June 6, 1901. The work of excavation was resumed on June 5, 1901. The contract expires December 1, 1901, but it is not expected that the work will then be completed. The amount of material removed during the fiscal year was 20,198 cubic yards, bank measurement, and the amount earned by the contractor was $45,849.46. The material being removed is limestone bed rock, and drilling and blasting are necessary before it may be excavated. The holes are drilled at the corners of 4-foot squares, and the number of hours worked by the drills was 5,310. The number of holes drilled was 13,367, being 104,056 linear feet. The number of pounds of dynamite used was 96,821.

During the fiscal year the number of hours worked by the drills was 5,184 and the number of holes drilled was 12,954, being 101,859 linear feet. The number of pounds of dynamite used was 94,734.

Regarding the working season as extending from May 1 to December 1, the contract has been in force two hundred and forty-seven days, this being 62 per cent of the total time until the expiration of the contract. During this time the contractor has earned about 26 per cent of the total amount which may be earned under this contract, and has improved by dredging about 30 per cent of the total area. The work performed is still incomplete, however, as some redrilling and dredging and work with diver and derrick scow will be necessary to secure the required depth. The area improved by drilling and blasting is about 40 per cent of the total area.

Item B. Between the lower end of Lime Kiln crossing and Bar point.—The object of this improvement was to do such work as would contribute to making a channel depth of 21 feet for a width of 600 feet along Bois Blanc Island and Hackett ranges, and of 500 feet along Amherstburg reach. The least depth prior to improvement was about 17.5 feet. The work was performed by a dredging plant furnished and operated by M. Sullivan, of Detroit, on the basis of "time work" under formal contract dated July 6, 1900; a dredging plant furnished and operated by James B. Donnelly, of Buffalo, N. Y., on the basis of "time work" under oral agreement, two derrick scows with diving outfits, one steam drill, and one tug, all operated by hired labor.

The Sullivan dredge worked between July 11, 1900, and December 4, 1900, when the contract was completed on account of the ceasing of operations for the season. The area improved by this dredge was about 80,000 square yards, located along Amherstburg reach. The dredge worked 1,209¼ hours at $14.50 per hour, and the amount earned by the contractor was $17,532.91. The amount of material removed was 21,891 cubic yards, at a cost to the United States of 80½ cents per cubic yard scow measurement. This material consisted of clay, sand, loose stones, and bowlders, and some bed rock. Over a large part of the area improved it was necessary to scrape bed rock in order to remove this material.

The Donnelly dredge worked between October 4, 1900, and December 4, 1900. The area improved was about 9,500 square yards, situated along the east channel line along Bois Blanc Island range. The dredge worked 295¼ hours at $9 per hour, and the amount earned by the contractor was $2,657.25. The amount of material removed was 10,175 cubic yards, at a cost to the United States of 26.1 cents per cubic yard, scow measurement. This material consisted of sand, clay, gravel, and bowlders, but no bed rock was found.

The two derrick scows with diving outfits were operated between July 1, 1900, and November 14, 1900, when one derrick scow was taken from the work, the remaining derrick scow continuing in operation until December 5, 1900. The steam drill was used between July 1, 1900, and November 1, 1900, and the tug continued in service between July 1, 1900, and December 6, 1900. The area improved by this plant operated by hired labor was about 484,000 square yards between the lower end of Lime Kiln crossing and a point about one-half mile south of Bois Blanc Island. The greater part of the work performed, however, consisted in the removal of bowlders thrown up by the Sullivan dredge along Amherstburg reach. During the fiscal year there were removed by the derrick scows when doing this work 4,012 bowlders, being about 1,930 cubic yards, at a cost to the United States of $5.48 per cubic yard, scow measurement.

During the month of April, 1901, a sweeping raft, derrick scow with diving outfit, and steam launch, all operated by hired labor, were engaged in locating and removing obstructions to navigation between the north end of Lime Kiln crossing and the south end of Bois Blanc Island. This work was performed at a cost to the United States of $583.50.

During the months of May and June the plant operated by hired labor was engaged in removing bowlders projecting above a depth of 21 feet in that part of the west half of the 600-foot channel along Grosse Isle, south channel range, which is not included within the limits of the present contract. The area cleared to 21 feet depth is about 115,000 square yards. The least depth within this area prior to improvement was about 19 feet. During the progress of this work 129 bowlders were removed, being about 110 cubic yards. The number of pounds of dynamite used was 150. This work was performed at a cost to the United States of about $1,400.

During the month of May, 1901, a channel 250 feet wide was cleared to a depth of 13 feet, to the west of the area under improvement at Lime Kiln crossing. The object of this improvement is to permit light-draft vessels to pass to the west of the work in progress, and thus lessen the danger of collision, which is liable to happen at this place, owing to the narrow channel and strong cross currents. This work was performed by the plant operated by hired labor, at a cost to the United States of about $150.

Amherstburg reach.—The contract here in force provides for a clear depth of 21 feet for a width of 500 feet and a length of channel of about 4,500 feet. The least depth prior to improvement was about 16.5 feet. This work is being performed by M. Sullivan, of Detroit, under formal contract dated June 6, 1901. The contract price for this work is $2.90 per cubic yard, bank measurement, and the maximum cost of this improvement is $284,200.

Work under this contract was commenced June 4, 1901, and the contract expires December 1, 1902. The amount of material removed was 3,986 cubic yards and the amount earned by the contractor was $11,559.40. The material removed consisted of clay, sand, loose stones, and bowlders. Drilling and blasting were not necessary in order to remove this material. A large amount of limestone and bed rock will, however, be removed under this contract and the work of drilling and blasting this material was commenced on June 19, 1901. The holes were drilled at the corners of 4-foot squares and the drill worked one hundred and eighty-two hours. The number of holes drilled was 276, being 1,104 linear feet. The number of pounds of dynamite used was 1,182.

The following is a résumé of the work performed under the several improvements and the cost to the United States:

Location.	Contractor.	Nature of contract.	Cubic yards.	Cost.
Foot of Fighting Island	Edward J. Hingston	Time work of dredging plant.	10,108	$2,880.95
Grosse Isle, south channel range.	Buffalo Dredging Co	Bank measurement	32,346	62,997.13
	Hired labor		110	1,400.00
Lime Kiln crossing	James B. Donnelly	Bank measurement	20,198	45,849.46
Between the lower end of Lime Kiln crossing and Bar point.	do	Time work of dredging plant.	10,175	2,657.25
	M. Sullivan	do	21,891	17,532.91
	Hired labor		1,930	10,575.00
Amherstburg reach	M. Sullivan	Bank measurement	3,986	11,559.40
Total			100,744	154,952.10

As a result of these several improvements the present condition of the channel is as follows: There is a clear depth of 21 feet for a width of 600 feet (300 feet each side of the sailing line) from Detroit to the head of Ballards reef. Through Ballards reef to Lime Kiln crossing there is a clear depth of 21 feet for a width of 300 feet east of the range line and a contract now in force providing for a clear depth of 21 feet for a width of 300 feet west of the range line, but no part of this additional width is yet available to navigation. Along the Lime Kiln crossing range there is a clear depth of 19 feet for a width of 440 feet, with a contract in force providing for the clearing to 21 feet depth of an additional 160 feet to the westward, but no part of this additional width is yet available to navigation. At Lime Kiln crossing there is also a channel 250 feet wide cleared to a depth of 13 feet to the west of the area under improvement. From the lower end of the Lime Kiln crossing to a point one-half mile south of Bois Blanc Island there is a clear depth of 19 feet for widths varying from 280 feet along Amherstburg reach to 500 feet along Bois Blanc Island and

Hackett ranges. There is a contract in force providing for a "clear depth" of 21 feet for a width of 500 feet throughout the greater part of the length of Amherstburg reach. For one-half mile south of Bois Blanc Island to Bar point there is a clear depth of 21 feet for a width of 600 feet, and from Bar point to Detroit River lighthouse there is a clear depth of 20 feet for a width of 800 feet.

In this report, when depth of water is mentioned, the plane of reference is a water surface corresponding to a stage of water at Lake Erie of 572.50 feet above mean tide at New York, except as relating to the contract now in force at Amherstburg Reach, where the plane of reference is 1 foot lower.

Surveys.—During the months of September, October, and November, 1900, surveys for a new channel at the mouth of the Detroit River were made along the routes designated as "Plan B" and "Plan C" in your report to the Chief of Engineers dated May 29, 1900. The object of these surveys was to obtain soundings that would enable a more accurate estimate being made of the amount of material to be removed. The area covered by these surveys was 700 feet wide and 32.000 feet long at "Plan B," and 46,300 feet long at "Plan C." While making these surveys 106,100 soundings were taken at a cost of $1,765, being $1\frac{7}{10}$ cents per sounding. A detailed report giving results and estimates based on these surveys was submitted under date of December 24, 1900. The estimated cost of a 21-foot channel along "Plan B" was $7,606,060, and along "Plan C" $9,913,871, the width of channel in each case being 600 feet.

During the month of December, 1900, a survey was made at Section 2—Lime Kiln Crossing—to show change due to improvement. These soundings were taken from the sweeping raft at the corners of 10-foot squares, the sweeping raft being anchored in the desired positions. During this survey 1,911 soundings were taken at a cost of $59, being $3\frac{1}{10}$ cents per sounding.

During the months of January and February, 1901, ice surveys were made, to show changes due to recent improvements, both as regards the excavation and disposal of material during recent improvements. A survey was also made to better develop the channel leading to Wyandotte, Mich. The number of soundings taken was 54,525, at a cost of $855, being $1\frac{6}{10}$ cents per sounding.

The office work of reducing the soundings taken when making these several surveys to the plane of reference and of plotting the reduced soundings on tracing linen has been completed and the tracings transmitted.

An investigation was made to determine what surveys were necessary preliminary to an improvement with a view to "obtaining a sufficient depth of water in the channel to the west of Grosse Isle" as called for by act of Congress dated June 6, 1900. A report showing the industries that would be affected by such improvement was submitted under date of October 10, 1900. The surveys answering the purpose of this act of Congress were made during the months of October and November, 1900, and February, 1901.

Triangulation.—The system of triangulation was extended from the south end of Grosse Isle to the vicinity of Trenton, along the Trenton channel of the Detroit River. Fifteen new triangulation stations were established and their coordinates computed. The marks for some of these stations are, however, of only a temporary nature.

Water-gauge readings.—Water-gauge readings are now being taken at half-hourly intervals at Sandwich coal dock and at Smith's coal dock, just south of Detroit, for the purpose of determining the slope in the river between these points and Lake Erie. It is the intention to continue these readings throughout the season. The object of this work is to obtain sufficient data to enable signals being posted at these points indicating to vessel captains the safe navigable depth in the lower reaches of the Detroit River at all stages of water and under all conditions of weather.

The automatic water gauge at the mouth of the Detroit River has been attended to regularly during the year, and the record derived therefrom has been reduced. The following are the elevations above mean tide at New York, of the mean stage for the several months:

Date.	Elevation.	Date.	Elevation.
1900.	*Feet.*	1901.	*Feet.*
July	572.34	January	571.34
August	572.32	February	570.96
September	571.98	March	570.80
October	571.80	April	571.16
November	571.32	May	571.33
December	571.36	June	571,80

The highest stage of water during the year was at an elevation of 574.03 feet, on September 12, 1900, and the lowest stage was at an elevation of 567.30, on November 21, 1900. The greatest variation during the year was, therefore, 6.73 feet. The greatest variation during one day was on September 12, 1900, when the stage varied 5.83 feet. Also, on November 21, 1900, the stage varied 5.63 feet, and again on December 9, 1900, the fluctuation was 4.13 feet. These extreme fluctuations in the stage of water were all due to heavy gales.

Very respectfully, your obedient servant,

CHAS. Y. DIXON,
Assistant Engineer.

Col. G. J. LYDECKER,
Corps of Engineers, U. S. A.

P P 8.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

WRECK OF SCHOONER LEADER.

This vessel, loaded with coal dust, was sunk by collision in the main channel of the Detroit River near the head of Belle Isle, and the wreck was a dangerous obstruction to navigation. It was so reported from this office August 27, and an allotment of $2,500 to pay the expenses of removing it was duly made September 1, 1900. The work of removal was done under formal contract by John B. Quinn & Co., of Detroit, Mich., for the lump sum of $1,750. Operations under this contract were in progress from October 3 to November 3, when the locality was carefully examined with sweeping raft and the channel found clear of all obstructions to the prescribed depth of 21 feet. The work consisted in blasting the wreck with dynamite and removing the pieces by derrick boat and dredge. Nothing of value was recovered from the wreck.

The total cost of removal was $2,050.06, viz, $1,750 paid to contractor, $235 for superintendence and engineering, $65.06 for advertising and job printing. The unexpended balance of the allotment was $449.94, and this was duly deposited with the assistant treasurer of the United States, at Chicago, Ill., to credit of the Treasurer of the United States, December 21, 1900.

WRECKS OF SCHOONERS FONTANA AND MARTIN.

These two vessels, both loaded with iron ore, were sunk by collision in the so-called rapids at the head of St. Clair River, the former August 4, 1900, and the latter September 21, 1900. The two wrecks lay about 1,250 feet apart, in a rapid current, and combined to make the navigable conditions critically dangerous. Prompt measures were accordingly taken for their removal, and provisional allotments aggregating $11,200 were made for that purpose, viz, $10,000 for the *Fontana* and $1,200 for the *Martin.*

The work of removing these wrecks was in progress from September 23 to November 20, 1900, when careful examinations were made with sweeping bars and no obstructions found within 25 feet of the water surface at the site of *Fontana* and 22 feet at the *Martin.* Operations on the *Fontana* consisted in blasting the hull with dynamite and cleaning all débris to a depth of 25 feet with a powerful dredge. Operations connected with the *Martin* consisted in tearing away spars, rigging, etc., but it was not necessary to do any work on the hull because the clear depth of water over it was found to be not less than 22 feet. In addition to work on the wrecks, a special system of day and night marks were established and an active patrol service maintained in order to regulate the movements of vessels passing through the obstructed channel and to enforce observance of certain temporary rules which were promulgated by printed notice September 24, 1900, as follows:

NOTICE TO VESSEL MASTERS.

United States Engineer Office,
Detroit, Mich., September 24, 1900.

Under the provisions of the river and harbor act of March 3, 1899, the Secretary of War of the United States has assumed control of the removal of the wrecked schooners *Fontana* and *Martin* at the head of St. Clair River, and the following directions must be strictly observed by all vessels approaching and passing the locality:

Steamers with more than one schooner in tow will be required to take a tug to assist in passing the wrecks or break-up.

Boats will not be allowed to meet or pass each other within one-half mile of wrecks, downbound having right of way.

DOWNBOUND BOATS.

Downbound boats will not be permitted to pass the wrecks at night. Boats arriving at the light-ship after 5.30 p. m., standard time, will come to anchor above the light-ship, leaving a clear passage for upbound craft, and thereafter boats will arrange themselves in order of their arrival; a boat will not pass another at anchor below her. At daylight, boats will pass down the river in order of their arrival at anchorage ground, downbound boats having continuous right of way until the entire fleet has passed.

The following sailing directions will apply to downbound craft: Keep to westward of Fort Gratiot range to pass clear of *Fontana* and when abreast of her head on Botsford's elevator.

UPBOUND BOATS.

In all cases, upbound boats will check and wait below Fort Gratiot front range light for any downbound boats below the light-ship to pass.

Downbound boats, which are not allowed to pass at all during the night, will have right of way in the morning until the fleet has passed down, and upbound boats must stay below Fort Gratiot front range light until notified that downbound fleet has passed, when they will proceed in order of arrival.

Sailing directions for upbound boats: Keep on Fort Gratiot range till abreast of the *Martin*, then starboard wheel to pass clear of *Fontana* and head on light-ship. Black buoy opposite light-house marks limit of 20-foot depth and all vessels may safely lay a direct course from this buoy to the light-ship.

Upbound passage is possible to east of *Fontana* if boats keep well to the eastward, where deep water will be found close to the Canadian shore in immediate vicinity of wrecks. This course is necessary because of the strong current setting from Canadian shore toward the *Fontana*.

United States patrol tugs are stationed above and below, and such further instructions as may be communicated from them must be observed.

G. J. Lydecker,
Lieut. Col., Corps of Engineers, U. S. A.

Shortly after navigation opened in the spring of 1901 it was represented that several vessels touched on some obstruction in the vicinity of the wreck of the *Martin*, and the locality was therefore carefully swept again with suspended bars May 20–23, 1901, but no evidence of any obstruction above a depth of 24 feet could be found. Some interesting features were noted in connection with this examination, and reported by Mr. E. S. Wheeler, assistant engineer, as follows:

"Under your instructions I proceeded with the steamer *Hancock* to Port Huron, arriving there on the 20th ultimo. A bar of railroad iron was procured and slung over the side of the *Hancock*. The bar was held by a line at each end. These were kept vertical by a line running from the upstream end of the bar to the bow of the boat, about 50 feet. The *Hancock* was anchored with a line about 600 feet long, so that she could be swung from side to side over the wreck by means of her rudder. It was noticed that when in the strongest current the upstream end of the bar would sink only to 15 or 16 feet; the downstream end would sink to 28 feet. The lower end of the bar was bent so that when in this position about 8 feet of it would be very nearly horizontal. The bar was first swung at a depth of 28 feet, until the wreck was found. The bar was then raised to 22 feet and swung over the entire wreck without touching anything. Soundings were taken with a lead line to the deck of the boat. They varied in depth from 25 feet at the stern to 40 feet near the bow. They are shown on the accompanying sketch. The swift current made soundings quite difficult, the line being often entangled in the wreck. Two leads and a line were lost. A small anchor was also lost. The work was completed May 23. The shallowest part found on the wreck was 24 feet deep. It is, therefore, no obstruction to navigation.

* * * * * * *

"In swinging the *Hancock* from side to side it was noticed that when she passed over the wreck a slight jar or shock was felt and there was a tendency to change her direction. This was probably due to a difference in the strength and direction of the current on the two sides of the wreck.

"The *Hancock* was drawing only 7 feet. It is probable that a boat of deep draft would feel this change in the current much stronger, and possibly enough to cause the master to think that his boat had touched the wreck. This is the only explanation that can be suggested for the recent reported groundings. It is noticed that all boats that reported grounding passed on over the wreck without difficulty."

* * * * * * *

The total expenditure made in connection with operations on these wrecks is as follows:

For *Fontana:*		
Paid to contractor	$7,000.00	
Miscellaneous bills for services and supplies	862.35	
Pay rolls for superintendence and engineering	426.16	
		$8,288.51
For *Martin:*		
Miscellaneous bills for services and supplies	710.19	
Pay rolls for superintendence and engineering	399.70	
		1,109.89
		9,398.40

In addition there are outstanding claims aggregating $3,426.06 on account of work connected with the removal of the *Martin* wreck and for tug service furnished for patrol duty in regulating movements of passing vessels; but these claims are considered as unreasonable and exorbitant in some of their items, and their settlement has therefore been delayed. It is probable that the available balance of allotments ($1,801.60) will be applied toward the settlement of these claims when they are finally and satisfactorily adjusted.

P P 9.

PRELIMINARY REPORT ON SURVEY OF WATERS CONNECTING LAKES SUPERIOR AND HURON, INCLUDING HAY LAKE CHANNEL, ST. MARYS RIVER, WITH A VIEW TO SECURING A CHANNEL 21 FEET DEEP.

[Printed in House Doc. No. 128, Fifty-sixth Congress, second session.]

Office of the Chief of Engineers,
United States Army,
Washington, December 1, 1900.

Sir: The item of the river and harbor act approved March 3, 1899, making appropriation for the improvement of Hay Lake channel, St. Marys River, Michigan, contained the further provision:

> That the Secretary of War shall cause to be made and reported, as early as practicable, a survey of the connecting waters between Lakes Superior and Huron, including Hay Lake channel, with a plan and estimate of the cost of such improvements as will secure a safe and convenient channel 21 feet deep between said lakes, the expense of which shall be paid from the said appropriation for improving Hay Lake channel.

The project involved in the plan and estimate thus provided for is of considerable magnitude, and further work in both office and field is needed; but, with a view to presenting this important matter to Congress as soon as practicable, I have the honor to submit the accompanying copy of a preliminary report on the subject, dated June 4, 1900, by the local officer, Lieut. Col. G. J. Lydecker, Corps of Engineers. An outline is given of the alternate plans for improvement that will be discussed at length in the final report, which will also be submitted during the present session of Congress. The maximum total cost of the works to be proposed is now estimated at $9,000,000. It is not unlikely that these figures may be materially reduced by a further study of the complicated questions involved, but in the opinion of the local officer no less radical improvement will meet the demands of the St. Marys River commerce.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

Hon. ELIHU ROOT,
Secretary of War.

REPORT OF LIEUT. COL. G. J. LYDECKER CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., June 4, 1900.

GENERAL: I have the honor to submit the following, as a preliminary report, in relation to survey, plan, and estimate for securing a channel 21 feet deep through the St. Marys River, Michigan, as called for by the following extract from the river and harbor act of March 3, 1899:

Improving Hay Lake Channel, St. Marys River: * * *

> *Provided further*, That the Secretary of War shall cause to be made and reported as early as practicable a survey of the connecting waters between lakes Superior and Huron, including Hay Lake Channel, with a plan and estimate of the cost of such improvement as will secure a safe and convenient channel twenty-one feet deep between said lakes, the expense of which shall be paid from the said appropriation for improving Hay Lake Channel.

Field work on the required survey was in progress during the summer and fall of 1899 and part of the past winter, and a great deal of office work has been applied to the reduction and study of the data thus obtained; but further work in both office and field is needed before a full and exhaustive report can be prepared in relation to the important subject that is to be considered. Enough has been done, however, to permit the presentation of a statement that will outline the present general condition of the navigable channel through the St. Marys River via Hay Lake and indicate the way in which the desired improvement may be secured, together with approximate estimates of cost.

The distance between Lakes Superior and Huron by way of the channel referred to above is 64 miles; but the existing channel is a reasonably safe and convenient one, with a depth of 21 feet or more in two sections of the river, aggregating 30 miles in length, or nearly one-half of the total distance—viz, the upper section, 14 miles long, extending from Lake Superior to the head of the St. Marys Falls Canal at Sault Ste. Marie, Mich., and the lower section, 16 miles long, extending from Point aux Frenes at the foot of Mud Lake to Lake Huron. The intermediate section, included between the head of the canal and Point aux Frenes, is 34 miles, and extensive improvements will be required in this division in order to "secure a safe and convenient channel 21 feet deep." Two plans of improvement have been suggested, and the two outline maps[1] submitted herewith will probably suffice to illustrate their distinctive features.

In this part of the river there are about 14 miles of dredged channel, 12 miles of which have a width of only 300 feet, and there are several dangerous angles in the channel. It is very evident that the channel in its present condition is neither safe nor convenient for the amount and character of traffic now passing through it. The project under which these improvements were made called for a depth of 20 feet at mean stage of water, this stage having been deduced from records of gauge readings from 1870 to 1890, a period of twenty years; but during the past eight years the actual stage of water has been continuously below that mean stage by as much as from 1 to 2 feet generally, and occasionally even 3 feet. The actual depth of improved channels is therefore found to be from 18 to 19 feet only, and in order to obtain a low-water depth of 21 feet these channels will have to be made about 3 feet deeper than they are now.

The two projects of improvement that have been considered for this part of the river are: First, to remove the several shoals and parts of shoals between the canal and the upper entrance to Hay Lake Channel, so as to provide a channel 1,000 feet wide through this distance of about 2 miles; to widen the various sections of channel, via Little Rapids Cut, Hay Lake, Middle Neebish, Little Mud Lake, Sailors Encampment, and Mud Lake, so as to provide a least width of 600 feet and a clear depth of 21 feet at ordinary low water. The second plan is the same as the first until deep water is reached in Hay Lake, viz, to remove shoals between St. Marys Falls Canal and the upper entrance to Hay Lake, and widen and deepen the present upper entrance channel into Hay Lake so as to give it a least width of 600 feet and clear depth of 21 feet at low water; to provide a new outlet channel from Hay Lake to Mud Lake via the West Neebish, giving it a least width of 300 feet and low-water depth of 21 feet; and to deepen the old channel between Hay Lake and Mud Lake (via the Middle Neebish) to 21 feet, leaving its width unchanged.

The cost of the first, or Middle Neebish, project has been estimated by Assistant Engineer Benno Rohnert, who had immediate charge of the related surveys, at $6,250,000 in round numbers; and of the second, or combined Middle and West Neebish projects, at $5,750,000.

In addition to improving the open river section in substantial conformity to one of the foregoing projects, further improvements of the St. Marys Falls Canal are needed for the convenient and expeditious passage of the existing and rapidly increasing commerce, the more so as the size of vessels engaged in this commerce is also increasing very fast. To meet these conditions a project has been studied which looks to rebuilding the Weitzel Lock and widening the canal above the locks, the cost of which has been estimated by Assistant Engineer Joseph Ripley, general superintendent of the canal and engineer in local charge of St. Mary's river improvements, at $3,000,000 in round numbers.

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[1] A single map contains the consolidated data. Not reprinted; printed in House Doc. No. 128, Fifty-sixth Congress, second session.

Summarizing the above, it appears that the total cost of securing such safe and convenient channel as is indicated by Congress will be in the neighborhood of $9,000,000, according to either of the projects herein suggested, and it is believed that no less radical improvement will meet the demands of the St. Marys River commerce. The estimated cost is to be taken as a maximum, and it is not unlikely that it may be materially reduced by further study of the complicated questions involved in the best final solution of the problem.

A discussion of comparative merits of the alternate projects is not considered necessary or advisable in this preliminary statement, but, considering the large expenditure that will attach to the adoption of either one, attention is invited to the following summary indicating the present commerce through the river and its rapid growth during the past five years.

Calendar year.	Freight.	
	Tons.	Valuation.
1895	15,062,580	$159,575,129
1896	16,239,061	195,146,842
1897	18,982,755	218,235,927
1898	21,234,664	233,069,740
1899	25,255,810	281,364,750

The above statistics are taken from the official records of traffic through the American and Canadian canals at Sault Ste. Marie, and do not include any purely local traffic on the river.

Very respectfully, your obedient servant,

G. J. Lydecker,
Lieut. Col., Corps of Engineers.

Brig. Gen. John M. Wilson,
Chief of Engineers, U. S. A.

P P 10.

EXAMINATION AND SURVEY OF ST. CLAIR FLATS CANAL, MICHIGAN.

[Printed in House Doc. No. 234, Fifty-sixth Congress, second session.]

Office of the Chief of Engineers,
United States Army,
Washington, December 19, 1900.

Sir: I have the honor to submit the accompanying copies of reports, dated, respectively, July 28 and December 6, 1900, with map,[1] by Lieut. Col. G. J. Lydecker, Corps of Engineers, upon preliminary examination and survey, made to comply with the provisions of the emergency river and harbor act of June 6, 1900, of St. Clair Flats Canal, Michigan, with a view to doubling its capacity.

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[1] Not reprinted; printed in House Doc. No. 234, Fifty-sixth Congress, second session.

The actual navigable depth now prevailing in the canal during the season of navigation does not exceed 19 feet, while the width of the channel dredged to the 20-foot depth between revetments is only about 260 feet. The local officer states that the sinking of a vessel in this narrow channel would cause a complete blockade of deep-draft navigation for a considerable period, and that the liability of blockade would be very much reduced and the passage of commerce greatly facilitated were the capacity of the canal doubled.

The plan of improvement presented contemplates the dredging of a new channel 300 feet wide and parallel to the present canal, the depth to be 21 feet at low water in order to have a clear navigable depth of 20 feet at that stage. There will thus be afforded separate channels for vessels moving in opposite directions. The cost of the proposed improvement is estimated at $330,000, and in the opinion of Colonel Lydecker the work can be accomplished without exceeding the estimate given, provided it be done with a single appropriation of the amount indicated or under the continuous-contract system, and that under such conditions it could be completed by July 30, 1902.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

ELIHU ROOT,
Secretary of War.

PRELIMINARY EXAMINATION OF ST. CLAIR FLATS CANAL, MICHIGAN, WITH A VIEW TO DOUBLING ITS CAPACITY.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., July 28, 1900.

GENERAL: Under instructions contained in Department letter of June 13, 1900, I have the honor to submit the following report respecting preliminary examination of the "St. Clair Flats Canal, in Lake St. Clair: With a view to doubling the capacity" of the canal, as required by section 2 of the emergency river and harbor act of June 6, 1900. No allotment from the appropriation made by the act was necessary for the examination, report to that effect having been made in my telegram to the Chief of Engineers of the 8th instant.

This locality is perfectly familiar to me, and no further examination could make it more so. When serving as assistant to Col. T. J. Cram, Corps of Engineers, U. S. A., in 1867–68, I made the detailed survey on which the location of the present canal is based, and after making the location had immediate charge of the work of construction during the first year of its progress. For the past five years the canal has formed a part of the river and harbor district in my charge, and, being only a few miles from my station in Detroit, has been more immediately under my personal observation than any other work in the district. During two recent visits, on July 6 and 27, I made careful examination of the work, and am fully advised as to its present condition in every respect.

The canal extends through an extensive flat at the mouth of the main channel of the St. Clair River, and—as an integral part of the 20-foot ship channel between Chicago, Duluth, and Buffalo—forms the connecting link between the deep waters of that river and Lake St. Clair. The width, measured from face to face of the lateral dikes, is 292 feet, but the width of dredged channel between dikes does not exceed 260 feet.

Through this narrow channel, which is about 1¼ miles in length, all through commerce on the Great Lakes must pass. The necessity for increased width has long been recognized, and this fact has been pointedly suggested in my annual reports for 1896 and 1899, my statement in the last report (p. 2998) being as follows:

> This matter is of such importance that I feel justified in taking the exceptional course of suggesting that it be brought to the attention of Congress with recommendation that action be taken with a view to doubling the present commercial capacity of channel so far as width is concerned.

Shortly after that view was expressed the imperative necessity for the suggested increase in width was strongly accentuated by the grounding of the tow barge *John Fritz* at the lower entrance, causing a blockade of the channel by which the passage of deep-draft vessels was made impossible for a period of about one and one-half days (December 4 to 6, 1899).

There is no record in any department of the Government showing definitely the amount of commerce passing through the canal, but the records of the United States custom-houses on the lakes supply data for a reasonably close approximation. In this way it has been deduced that the total freight carried by vessels which passed through the canal during the calendar year 1898 was about 35,000,000 tons. The Annual Report of the Chief of Engineers for 1899, pages 3004 to 3012, contains a full explanation of the manner in which this approximation was arrived at, and shows in great detail the data on which it is based. In the same way, and from data of the same character, the total freight traffic for the calendar year 1899 has been estimated at over 36,000,000 tons. I am inclined to think that these figures may be a little too large, but even if this be so, they represent the true condition of affairs with sufficient accuracy for the purpose now in view. Their reduction to the greatest permissible extent would still show a commerce of such vast proportions as would justify expenditures on the most liberal scale for any work needed for its security or benefit. Even a duplication of expenditures thus far made on this canal would be insignificant in comparison with the commercial interests involved, but much less will probably suffice for doubling its capacity, as now proposed.

For the reasons above indicated, I have no hesitation in reporting that the proposed improvement is in the highest degree advisable. The records of this office already contain sufficient information for a reasonably close estimate of probable cost, but a little work in extension of surveys already made is desirable in order that the estimate be made as exact as possible. There is an unexpended balance of former appropriations for improving the canal available for paying all expenses that will attach to the desired survey.

Very respectfully, your obedient servant,

G. J. LYDECKER,
Lieut. Col., Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
July 31, 1900.

Respectfully submitted to the Secretary of War.

This report relates to preliminary examination with a view to doubling the capacity of the so-called St. Clair Flats Canal, Michigan, provided for in the emergency river and harbor act approved June 6, 1900.

The canal is about a mile and a half long, but the width of dredged channel between the dikes does not exceed 260 feet. The commerce passing through this narrow channel is more than 30,000,000 tons annually.

The necessity for the suggested increase in width is clearly stated by Colonel Lydecker, and he reports that the proposed improvement is in the highest degree advisable. I recommend that the necessary surveys be made and an estimate of cost of improvement be submitted. The expenses connected with this work can be paid from the balance remaining from former appropriations for improving St. Clair Flats Canal.

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

[Second indorsement.]

WAR DEPARTMENT,
July 31, 1900.

Approved as recommended by the Chief of Engineers.

By order of the Secretary of War:

JOHN C. SCOFIELD,
Chief Clerk.

SURVEY OF ST. CLAIR FLATS CANAL, MICHIGAN, WITH A VIEW TO DOUBLING ITS CAPACITY.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., December 6, 1900.

GENERAL: I have the honor to submit report and estimate related to a survey called for by the following extract from section 2 of the emergency river and harbor act approved June 6, 1900, viz:

> Michigan * * * St. Clair Flats Canal, in Lake St. Clair: With a view to doubling the capacity of the so-called St. Clair Flats Canal.

The construction of this canal was commenced under the river and harbor act of March 2, 1867, which called for—

> a straight ship canal from sufficiently deep water at the mouth of the South Pass of St. Clair River * * * to deep water in Lake St. Clair, * * * the canal to be 300 feet wide and 13 feet deep below lowest known water, with sides diked and banked, etc.

The canal was duly completed according to these provisions, at a cost of $460,090, and opened to navigation July 25, 1871. Since that time the navigable depth has been successively increased, first from 13 to

16 feet, then to 18 feet, and finally to 20 feet, but the increased depths relate to a "mean stage of water" instead of the lower stage contemplated by the original project, and the result is that the actual navigable depth now prevailing during the season of navigation does not exceed 19 feet. The original width between dikes was 300 feet, but that width was subsequently reduced to 292 feet by new sheet-pile revetments on the channel side of each dike, and the width of channel dredged to the 20-foot depth between these new revetments is only about 260 feet. Therefore the present navigable width of channel is only a little more than four-fifths of what it was in 1872; but in the meantime freight traffic through the canal has increased from about 3,000,000 to 40,000,000 tons during a period of navigation that does not exceed eight and one-half months annually. The sinking of a single vessel in this narrow channel would make a complete blockade of deep-draft navigation for a considerable period. It is evident that the liability of blockade will be very much reduced and the passage of commerce greatly facilitated if the capacity of the canal be doubled.

There are two ways in which this improvement may be accomplished—(*a*) by removing the present westerly dike of the canal and dredging so as to increase the width of the present channel to 600 feet; (*b*) by dredging a new channel 300 feet wide parallel to the present canal, leaving the westerly dike in place, providing separate channels for vessels moving in opposite directions, and if one of the channels should become obstructed the other would be available, for the time being, for both up and down bound traffic. The latter is believed to be the better plan. The location of the canal is shown on the following section cut from the chart of Lake St. Clair, and the red-shaded area indicates the limits of dredging that would be required for the suggested plan of improvement. This area has been carefully surveyed, as shown on the inclosed blue print.[1] It is proposed to make the channel 21 feet deep at low water, in order to have a clear navigable depth of 20 feet at that stage. The total amount of excavation that will be needed for this purpose has been computed to be 1,446,035 cubic yards, or, in round numbers, say 1,500,000 cubic yards. The unit cost of this work should not exceed 14 cents per cubic yard, though previous contracts related to like work on the present canal range from 12 to 23 cents.

In order to make a convenient entrance from and to the channel of the St. Clair River it will be necessary to avoid a slope on the easterly side of the new channel, and to do this will require a double sheet-pile revetment on that side similar to that on both sides of the present canal; but it is my opinion that the westerly side of the new channel will not need any revetment. The old north channel of the south pass of the St. Clair River was dredged to a depth of 13 feet in 1858, and a careful examination of that channel, which was made when the survey was in progress for the improvement now proposed, showed that the mid-channel depth was no less than when the dredging was completed, more than forty years ago; nor were any indications of deposit found within a distance of 2,000 feet below the cut then dredged. The location of this old cut is about 2,000 yards from the canal, and is shown on the foregoing excerpt from the chart of Lake St. Clair.

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[1] Not printed.

The estimated cost of the improvement herein contemplated and recommended is $330,000, as follows:

Dredging, 1,500,000 cubic yards, at 14 cents	$210,000
Sheet-pile revetment, 7,500 linear feet, at $12	90,000
Contingencies of engineering, office, superintendence, etc. (10 per cent)	30,000
Total	330,000

I am quite satisfied that the improvement can be accomplished without exceeding the cost above indicated, provided it be done with a single appropriation of the amount above indicated, or under the continuing-contract system. Under such conditions it is believed that the work could be completed by July 30, 1902.

Very respectfully, your obedient servant,

G. J. Lydecker,
Lieut. Col., Corps of Engineers.

Brig. Gen. John M. Wilson,
Chief of Engineers, U. S. A.

P P II.

PRELIMINARY EXAMINATION OF DETROIT RIVER, MICHIGAN, WITH A VIEW TO OBTAINING SUFFICIENT DEPTH OF WATER IN CHANNEL ON WEST SIDE OF GROSSE ISLE.

[Printed in House Doc. No. 82, Fifty-sixth Congress, second session.]

Office of the Chief of Engineers,
United States Army,
Washington, November 19, 1900.

Sir: I have the honor to submit herewith for transmission to Congress copy of report, dated October 20, 1900, by Lieut. Col. G. J. Lydecker, Corps of Engineers, upon preliminary examination authorized by the emergency river and harbor act approved June 6, 1900, of Detroit River, Michigan, "with a view to obtaining a sufficient depth of water in the channel on the west side of Grosse Isle."

Very respectfully, your obedient servant,

John M. Wilson,
Brig. Gen., Chief of Engineers, U. S. Army.

Hon. Elihu Root,
Secretary of War.

REPORT OF LIEUT. COL. G. J. LYDECKER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., October 20, 1900.

GENERAL: To meet the requirements of the river and harbor act of June 6, 1900, I have the honor to submit the following report on preliminary examination of "Detroit River, Michigan, with a view to obtaining a sufficient depth of water in the channel on the west side of Grosse Isle."

This channel leaves the main channel of the Detroit River opposite the village of Ecorse, Mich., and enters Lake Erie at the foot of Grosse Isle, the distance from its head to deep water in the lake being about 15 miles. A railway bridge, with double-swing draw, spans the channel just below the city of Trenton, about 8 miles below Ecorse. The general depth of channel down to the bridge is over 20 feet, and its width, between contours of 20-foot depths, ranges from 300 to 1,000 feet within these limits. Below the bridge the channel is obstructed by numerous shoals, and can be safely navigated only by light-draft vessels; for this reason the channel west of Grosse Isle is not used for through commerce, nor is there any place bordering on it having any considerable local commerce by water at present.

The principal industries are at the cities of Wyandotte and Trenton, both of which are above the railroad bridge. Wyandotte has a population of about 6,500, the principal industrial establishments being the Michigan Alkali Company and the American Shipbuilding Company. The alkali company is reported to have about 2,000 regular employees and the shipbuilding company about 500. The total freight handled at Wyandotte annually is stated to be about 800,000 tons, the in shipments being mainly coal, stone, and structural steel, and the out shipments finished products of the alkali works. Four large steel vessels have been built at the shipyard since January 1, 1900.

Trenton has a population of about 1,200, and the principal local industries are the Sibley stone quarries, a stave factory, and a flour mill. About 350 men are employed in the stone quarries, the daily output of which is stated to be about 1,500 tons; the stave factory is reported to employ 70 men.

The total freight handled annually at Wyandotte is represented as being about 800,000 tons and at Trenton about 500,000 tons, most of which is carried by the Michigan Central, Michigan Southern, and Lima and Northern railroads. Two small steamers are engaged in regular local river traffic during the season of navigation.

The depth of water in the channel west of Grosse Isle is now ample for local commerce down to the railroad bridge. To obtain the same channel depth from the bridge to deep water in Lake Erie would be a work of great magnitude, and the cost would probably be several million dollars. The expenditure that would be needed to open up this line as a through channel of deep water, for local commerce only, is believed to be wholly inadmissible at present. The question of making it a through channel for general commerce was referred to in my report of May 29, 1900, in relation to securing a safe and convenient channel 21 feet deep from Lake Erie to Detroit, and will be further discussed in a more full and complete report that will probably be submitted for consideration during the next session of Congress.

I am of the opinion, for the reasons above indicated, that nothing related to present or prospective local commerce will justify any deepening of this channel at this time. I also question the advisability of adopting it as a through line of interlake commerce, but, as hereinbefore indicated, this is a matter that will be dealt with in another report.

I submit herewith reports by Assistant Engineers C. Y. Dixon and B. H. Muehle, which contain further details in relation to this matter. They also indicate that a deepening of the channel was not the real object sought by those who were active in having the item to which this report refers placed in the last river and harbor act; but that a more convenient connection with the through channel of Detroit River is what is desired, with special reference to providing a direct approach around the head of Grosse Isle to the alkali works and shipyard at Wyandotte. Though no call has been made for report on such a project, I beg to state that existing commercial interests do not, in my opinion, justify any considerable expenditure for that purpose at present.

The channel and the general conditions now existing, are shown on the published lake survey chart[1] of Detroit River, a part of which is inclosed herewith.

Very respectfully, your obedient servant,

G. J. LYDECKER,
Lieut. Col. Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
October 25, 1900.

Respectfully submitted to the Secretary of War, concurring in the opinion of the local officer that improvement of the locality by the General Government, in the manner indicated by the act authorizing the examination, is not advisable.

JOHN M. WILSON,
*Brig. Gen., Chief of Engineers,
U. S. Army.*

[Second indorsement.]

WAR DEPARTMENT,
October 27, 1900.

The views of the local officer, as concurred in by the Chief of Engineers, are approved.

ELIHU ROOT,
Secretary of War.

REPORT OF MR. CHAS. Y. DIXON, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Amherstburg, Ontario, October 10, 1900.

COLONEL: In accordance with your verbal instructions, I have the honor to submit the following report as to the population, industries, and amount of freight handled at Wyandotte and Trenton, Mich., that would be affected by an improvement such as is contemplated by the act of Congress dated June 6, 1900. This act calls for an "examination of the Detroit River, with a view to obtaining a sufficient depth of water in the channel on the west side of Grosse Isle."

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[1] Not printed.

The information in this report pertaining to Wyandotte was obtained from Mr. M. R. Bacon, manager of the Michigan Alkali Works, and Mr. Creswell, superintendent of the American Shipbuilding Company, and that pertaining to Trenton, was obtained from the clerk of the Sibley stone quarry.

Wyandotte has a population of about 6,500, and the principal industries are the Michigan Alkali Works and the American Shipbuilding Company. The Michigan Alkali Works have regularly about 2,000 employees, and about 2,000 tons of freight are handled per day. This freight consists of stone and coal shipped in and the finished product from the works which is shipped out.

The American Ship Building Company have about 500 employees, mostly skilled labor, and during the past year 9,000 tons of steel and 2,600 tons of coal were shipped in. Four vessels have been built since January 1, 1900.

Trenton has a population of about 1,200, and the principal industries now are the Sibley stone quarry, a stave factory, and a flour mill. Salt works are also about to be started under the same management as the stone quarry.

The Sibley stone quarry employs about 350 men, and ship out 1,500 tons of stone per day. The salt works will employ about 75 men, and the stave factory employs about 70 men.

The freight handled annually by the various industries at Wyandotte is about 800,000 tons, and at Trenton about 500,000 tons. The greater part of the freight is carried by the railroads, which are the Michigan Central, Michigan Southern, and Lima and Northern. Package freight is also carried by the electric railroad, and during a part of the year by the steamers *Wyandotte* and *Douglas*. The steamer *Wyandotte*, however, does not run to Trenton. If better facilities for shipping could be obtained the greater part of this freight would be carried by vessels at a much less cost, and undoubtedly other industries would be located along this part of the Detroit River.

Very respectfully, your obedient servant,

Chas. Y. Dixon,
Assistant Engineer.

Lieut. Col. G. J. Lydecker,
Corps of Engineers, U. S. A.

REPORT OF MR. B. H. MUEHLE, ASSISTANT ENGINEER.

United States Engineer Office,
Detroit, Mich., October 19, 1900.

Colonel: I have the honor to submit the following report in compliance with your instructions of the 17th instant relative to a preliminary examination of "Detroit River, with a view to obtaining a sufficient depth of water in the channel on the west side of Grosse Isle," required by the river and harbor act of June 6, 1900.

On the 18th instant I visited Wyandotte and Trenton, Mich., and interviewed Mr. M. R. Bacon, manager of the Michigan Alkali Company, which operates two large chemical works—one at the upper and the other at the lower end of the city of Wyandotte. Both are located along the shore of the Detroit River and have superior facilities for shipping by water, yet the company is compelled to receive and ship nearly all materials and the products of their factories by rail, owing to the absence of a convenient and direct connection between the main channel of the Detroit River and the "channel on the west side of Grosse Isle," along which the growing cities of Wyandotte and Trenton are situated.

Mr. Bacon admits that he, among other citizens, has been instrumental in having the above item inserted in the river and harbor bill, and regrets that it does not fully and clearly describe the nature of the improvements demanded by an increasing commerce and greatly desired by all the inhabitants of the only two cities, besides Detroit, which are located on the American shore of the Detroit River.

As a matter of fact, there is no need of obtaining a sufficient depth of water in the channel on the west side of Grosse Isle, at least not within the reach between Wyandotte and the Canada Southern Railroad bridge below Trenton. The channel width between the 20-foot contours along the Wyandotte River front averages 800 to 1,000 feet. The harbor line established in 1895 nearly covers the 20-foot contour, and the wharves of the several manufacturing establishments are being extended to that line, the Detroit Shipbuilding Works having built additions to two of their docks within the past year.

But this wide and deep part of the channel on the west side of Grosse Isle has only one outlet to the main river northward and that is a narrow channel along the village of Ecorse. Vessels coming from Lake Erie may approach the Wyandotte wharves by passing to the west of Mama Judy light-house and rounding the head of Grosse Isle, thus adding about 2 miles to the distance between the main channel and Wyandotte. Large freighters are not willing to lose the time required to cover these extra 2 miles in order to either leave or take up part loads of freight en route through the Detroit River, hence all materials for the shipyard (over 9,000 tons during a season) have to be taken to Detroit and reshipped from there to Wyandotte, and the Michigan Alkali Company can not make any satisfactory or profitable arrangements for shipping by water.

If there were a deep-water channel between the Canada Southern Railroad bridge and Lake Erie, the commerce of the cities of Wyandotte and Trenton would be materially benefited. But in view of the absence of any prospect of securing, in the near future, such a desirable southerly outlet, an appropriate substitute is suggested in the letter of Mr. Bacon of October 8, 1900, viz, dredging a channel or canal across the head of Grosse Isle, opposite the shipyard, thus furnishing the shortest possible connection between the main channel of the river and the docks at Wyandotte.

I am aware that the discussion of a scheme of this kind is not a proper subject within the scope of this report or the item in the river and harbor act calling for a preliminary examination, but I beg leave to suggest that the preparation of such a project with estimate of cost may be based upon data at hand and no survey would be required.

The commercial statistics of the cities of Wyandotte and Trenton have been fully set forth in the report of Assistant Engineer Charles Y. Dixon, dated October 10, 1900, and they are verified by Messrs. Bacon, Creswell, Kelly, and others, with the addition that, in the event of adequate channel improvements being provided, the amount of commerce which will at once avail itself of the increased facilities for shipping by water is estimated at not less than one million tons.

Hence, any improvements of the channel of the Detroit River on the west side of Grosse Isle, in the vicinity of the cities of Wyandotte and Trenton, having in view convenient approaches from north and south, or direct connection with the main channel, may be deemed worthy of favorable consideration by the Government on account of an extensive and growing commerce to be benefited.

Very respectfully, your obedient servant,

B. H. MUEHLE,
Assistant Engineer.

Lieut. Col. G. J. LYDECKER,
Corps of Engineers, U. S. A.

APPENDIX Q Q.

IMPROVEMENT OF RIVERS AND HARBORS ON LAKE ERIE WEST OF ERIE, PENNSYLVANIA.

REPORT FOR THE FISCAL YEAR ENDING JUNE 30, 1901, WITH OTHER DOCUMENTS RELATING TO THE WORKS. OFFICERS IN CHARGE, COL. JARED A. SMITH, COL. S. M. MANSFIELD, AND MAJ. DAN C. KINGMAN, CORPS OF ENGINEERS.

IMPROVEMENTS.

1. Monroe Harbor, Michigan.
2. Toledo Harbor, Ohio.
3. Port Clinton Harbor, Ohio.
4. Sandusky Harbor, Ohio.
5. Huron Harbor, Ohio.
6. Vermilion Harbor, Ohio.
7. Black River (Lorain) Harbor, Ohio.
8. Cleveland Harbor, Ohio.
9. Fairport Harbor, Ohio.
10. Ashtabula Harbor, Ohio.
11. Conneaut Harbor, Ohio.
12. Removing sunken vessels or craft obstructing or endangering navigation.

EXAMINATIONS AND SURVEYS.

13. Sandusky Harbor, Ohio.
14. Cleveland Harbor, Ohio.

United States Engineer Office,
Cleveland, Ohio, July 19, 1901.

General: I have the honor to forward herewith annual reports for works in my charge for fiscal year ending June 30, 1901.

Very respectfully, your obedient servant,

Dan C. Kingman,
Major, Corps of Engineers.

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. A.

HARBORS ON LAKE ERIE WEST OF ERIE.

In its natural condition Lake Erie afforded very few safe and commodious harbors west of Erie, Pa., that were of sufficient depth to be made use of by vessels suitable to lake navigation.

The Maumee River, near the western extremity of the lake, could be entered by vessels not drawing more than 8 feet of water, and the same may be said of the harbor of Sandusky, situated within the bay of that name. With these exceptions, the other harbors were found within the mouths of streams emptying into the lake. These streams or small rivers were generally deep enough for harbors at that time, but their mouths were obstructed by bars at or near the line of the lake shore, which were formed by the resultant action of the lake waves and the currents of the rivers. During the season when storms were prevalent in the lake the waves washed up the sand and gravel and almost completely closed the mouths of these streams, but during the time of the spring freshets the volume of the water discharged by the streams was generally sufficient to cut its way through the bar and to afford and maintain for a time a channel deep enough to permit the passage of the small vessels in use at that time. These channels, however, were constantly shifting, were of uncertain and varying depth, and were liable to be obliterated temporarily by storms.

The first effort of improvement therefore was directed to doing away with these river bars, and this was effected by the construction of parallel jetties extending outward into the lake so as to prolong the natural banks of the river and to confine its discharge to a channel of moderate width. The result was invariably to secure a deeper and better entrance, and if the material was such that the current of the river could move it, the bar was completely washed away and a channel secured and maintained between the jetties as wide and deep as the discharge of the river was capable of producing.

The shore of the lake is generally composed of sand or material so light that it is easily disturbed by the action of the waves, so that in time of storms when the waves break heavily upon the shore the water for a very considerable distance out in the lake, as far out at least as the water is shallow enough for the wave action to make itself felt upon the bottom, is filled with sand held temporarily in suspension. The natural currents in the lake which are generally strongest at such times move this silt-ladened water around the ends of the jetties, and a portion of its burden is dropped in such a way as to form a bar out in the lake beyond or across the improved channel. This effect is further increased by the silt brought down the river in the time of floods and deposited in the still water of the lake.

The shoaling due to this bar formation, and the natural demand for deeper channels due to the increased size of vessels gradually rendered a resort to dredging necessary, and now every harbor on the lake west of Erie, Pa., has been artificially deepened by the use of dredges. The jetties have lost their primitive function, which was an active one, namely, to cause a scouring out of the channel, and have become simply conservative in their nature. Their office is to protect and maintain the artificial channels which have been secured by dredging.

At Toledo no jetties have been constructed to protect the dredged channel, and at Sandusky the jetties are short and as yet incomplete. At Cleveland additional works in the form of breakwaters have been constructed to furnish a sheltered area outside and beyond the river mouth. This area, like the improved channels, has also a tendency to shoal. It is evident, therefore, that the real thing of value to navigation in this district consists of certain areas and channels artificially deepened by dredging, all the other works being now designed for their protection and preservation. No work that can be devised, however, will prevent the beach sand from being lifted and scattered by the waves in the time of storms, and no works will prevent the rivers from bringing down their annual burden of silt.

The utmost that can be hoped for in the way of permanence is to secure the construction of jetties and breakwaters of imperishable materials and of sufficient strength to resist indefinitely the forces to which they are exposed. After this it will only be necessary to maintain the depths which we desire by redredging as frequently as the local conditions may require it. This will, no doubt, be a continuous expense, but it need not be a heavy one if the district is properly equipped with machinery to execute the work.

To be compelled to resort to contracts to secure this dredging is, in my opinion, slow, cumbersome, and expensive. I think that the district should be provided with a hydraulic dredge of modern construction and design, capable of discharging the excavated material at a distance through a long pipe, or of receiving it in its own hoppers and transporting it with its own power to the dumping ground. Such a dredge should be of the seagoing type and should be capable of moving from place to place, or of working under any conditions likely to occur upon the lake. I am of the opinion that a suitable machine of this kind would cost about $250,000, and that the cost of operating it with a proper allowance for interest on the original investment and for repair and maintenance and for its care when not in use, would be $60,000 per annum; and I believe that such a machine can do all of the dredging of the kind which will be required in this district hereafter at a cost of less than half the price now paid for contract work.

I think that there would be sufficient work here in the future to keep such a machine constantly employed; but if it was not needed all the time in this district its service would always be valuable in the maintenance of the channels connecting the lakes or in the improvement and maintenance of other harbors. As it is difficult to foresee in advance just how much dredging will be necessary at any particular harbor in the district, I think it would be to the interest of navigation, as well as in the interest of economy, to provide a separate appropriation for the operation of this dredge within the district and permit it to be used wherever its services may be the most required.

Q Q 1.

IMPROVEMENT OF MONROE HARBOR, MICHIGAN.

A brief description of the harbor of Monroe and of projects and plans which have been submitted for its improvement are given in Report of Chief of Engineers, 1899, pages 3017 and 3018.

It may be stated, however, that this harbor is within the mouth of the Raisin River at the western extremity of Lake Erie. In its natural condition the water of the river found its way into the lake through a number of ponds and winding creeks which formed a delta in the midst of a marsh, most of which was submerged at ordinary stages of the lake. The depth of water at the deepest mouth of the river in its natural condition did not exceed 5 feet.

The project for the improvement of this harbor was adopted in 1834, and was practically completed in 1845. It had for its object to dredge a new and direct channel 100 feet wide and 10 feet deep from the lake across the marsh a distance of 4,000 feet to the portion of the river ordinarily used as a harbor. Incidentally, the old mouths of the river were to be closed up, and the new channel was to carry all the water directly to the lake. To protect the mouth thus artificially obtained, jetties were constructed extending outward to a depth of about 10 feet in the lake. The sides of the canal were protected by a revetment formed of oak sheet piling strengthened and held in place by anchor piles and waling pieces. The jetties were not parallel, but diverged, so as to give an entrance of greater width than 100 feet. They were constructed of timber, either piling or crib work, filled with stone. Subsequently, the improvement was extended up the river by the city of Monroe, which caused a cut about 1,400 feet long to be made across a long bend in the river to the wharves to about 2½ miles. The wharves are some distance from the city proper. The canal formed by the city had the same cross section and its banks were protected in the same manner as the United States canal.

These works were completed with the appropriation of 1845, and the total amount expended by the United States in the improvement up to that time was $110,000.

In the period of fifty-six years following this date there has been expended in maintenance $140,515.27, which is equivalent to an annual expenditure a little less than 2½ per cent of the cost of the original improvement. Such an expenditure is hardly sufficient to properly maintain such works as these when exposed to as many causes of deterioration as they are. The last two appropriations—that is to say, of 1896 and 1899, $10,000 in all—were required by law to be expended in continuing the improvement by dredging.

At the beginning of the fiscal year 1901 work was in progress under a contract with Edward J. Hingston, of Buffalo, N. Y., dated November 19, 1899, for dredging in the river and between and in the prolongation of the piers. This work was continued until July 20, 1901, when the contract was completed by the exhaustion of the funds. The total amount of dredging done under this contract was 34,300 cubic yards, of which a little more than one-third was done in the present fiscal year. This work left a channel about 200 feet wide and 13 feet deep, extending outward from the end of the jetties to deep water in the lake, and a channel about 60 feet wide extending inward between the jetties and through the United States canal.

An inspection made June 27, 1901, indicated that the depth in the lake had been generally maintained, and there was no special indication to fill to be found there. Nevertheless, there is a natural drift of bar-making material northward across the axial line of the jetties, and it is not probable that the current of the river flowing out from between them can maintain the dredged depth for a very long time or for any considerable distance out beyond the jetty heads. Within the jetties the depth has in general been maintained, but the width of the channel has been reduced by material washing in from the sides. The canal revetment has almost completely decayed above water. Below water, however, it is in fairly good condition, but is no longer held in place by the waling strips. However, the banks of the canal have become consolidated by time and are now generally covered by trees, and they are probably capable of standing by themselves with such little support as the old revetment will continue to afford them.

The piers are in need of repairs and I am of the opinion that these repairs when made should be of durable material and the old timber structures should be gradually done away with wherever they are above lake level.

From its size and depth this can only be regarded as a second-class harbor. None of the larger vessels can use it. Nevertheless, it is used quite extensively by small vessels and is undoubtedly convenient and advantageous locally.

The commercial statistics which have been collected show that the total receipts and shipments during the year 1900 amounted to over 6,500 tons, which was greater than that reported in the previous year. One hundred and nineteen vessels entered the harbor during the year and one vessel was built there.

As the Government has spent a considerable sum of money in the original construction and subsequent maintenance of this harbor, it would seem unwise to abandon it now if it can be maintained at moderate cost. I am of the opinion that a present expenditure of $10,000 for the maintenance of this harbor will be judicious, and it could be advantageously applied to the repair of the piers and the preservation of the channel by dredging.

Monroe is in the collection district of Detroit, Mich. There is a light-house on the outer end of north pier.

For a more detailed description of the work that has been done at this harbor during the past year and a fuller account of its condition at the time of the recent examination, I would respectfully invite attention to the report of Assistant Engineer William T. Blunt, which is transmitted herewith.

Money statement.

July 1, 1900, balance unexpended	$4,828.24
June 30, 1901, amount expended during fiscal year	4,828.24
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement	10,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

Amount and date of all appropriations for improving harbor at Monroe, Mich.

February 24, 1835	$30,000.00
July 2, 1836	15,000.00
March 3, 1837	30,000.00
July 7, 1838	15,000.00
June 11, 1844	20,000.00
August 30, 1852	14,000.00
June 23, 1866	31,015.27
June 10, 1872	10,000.00
March 3, 1873	15,000.00
June 23, 1874	10,000.00
March 3, 1875	10,000.00
August 14, 1876	5,000.00
June 8, 1878	2,500.00
March 3, 1879	2,000.00
June 14, 1880	$2,000.00
March 3, 1881	1,000.00
August 2, 1882	1,000.00
August 5, 1886	2,000.00
August 11, 1888	5,000.00
September 19, 1890	5,000.00
July 13, 1892	10,000.00
August 18, 1894	5,000.00
June 3, 1896	5,000.00
March 3, 1899	5,000.00
Total	250,515.27
Expended to June 30, 1901	250,515.27

CONTRACT FOR DREDGING IN HARBOR AT MONROE, MICH., IN FORCE DURING THE FISCAL YEAR ENDING JUNE 30, 1901.

Name of contractor: Edward J. Hingston, Buffalo, N. Y.
Date of contract: November 15, 1899.
Date of approval: December 5, 1899.
Date of commencement: May 1, 1900.
Date of completion: June 30, 1900.
Extended to: July 20, 1900.

COMMERCIAL STATISTICS.

The following statistics for the year 1900, relative to the commerce of the harbor of Monroe, Mich., were compiled from information furnished by the collector of customs and others:

Receipts.	Tons.	Shipments.	Tons.
Sand	3,355	Cedar poles	3,000
Coal	17	Fish	26
Stone	15		
Fish	95		
Total	3,482	Total	3,026

Total freight tonnage:

1900	6,508
1899	4,775
Increase	1,733

Vessels.	Number.	Tonnage.
Entering	119	16,267
Departing	118	16,286
Built	1	10

Total registered tonnage (vessels entering and departing):

1900	32,553
1899	51,312
Decrease	18,759

Draft of largest vessels using harbor, 10 feet. Largest vessels do not load to full depth. No new vessel lines established during the year.

Q Q 2.

IMPROVEMENT OF TOLEDO HARBOR, OHIO.

For a brief account of early history and projects of improvements see pages 2614 to 2616, Report of Chief of Engineers, 1898, and for the latest projects see pages 3020 and 3021, Report of Chief of Engineers, 1899.

For a complete statement and estimate of cost of the project of 1899, and maps to show the limitations of "portions" or "divisions" of this channel, made for convenience in estimating and carrying on the work, see Report of Chief of Engineers, 1898, pages 2693 to 2705, with accompanying maps.

During the last fiscal year the United States Dredging Plant had been continuously employed upon this improvement, except when it was necessary to suspend operations during the winter season or when the plant was temporarily transferred under an emergency to remove a shoal which had formed outside the jettied channel at the harbor of Fairport, Ohio.

During the winter of 1900–1901, the dredge and tug, and inspection steamer *Visitor* received minor repairs, and four of the dump scows were thoroughly overhauled and put in condition estimated to be as good as new. The cost of repairs to the scow was $8,215.18.

The entire cost of the dredging plant for the fiscal year was $25,072.47. The total amount of material removed was 184,996 cubic yards. The cost per cubic yard, about 13½ cents, is somewhat greater than that paid the contractor, but this is mainly due to the large amount expended in the repairs of the scows, which expenditure will not be necessary again for several years.

This plant is exceedingly useful as an emergency plant and ought to be kept in a thoroughly good and efficient condition. The dredge was built in 1893, and the tug was purchased at the same time. The hull of the dredge is of wood and is considerably decayed, and provision must soon be made for renewing it. When this is done the new hull should be of steel. The tug was not new when purchased, and its hull is now very much decayed and quite beyond economical repair. I am of the opinion that it would be best to sell it before it becomes entirely unserviceable and to purchase a new one for use with the dredging plant.

A continuous contract for excavating the straight channel, which was authorized by law, was entered into with the Lydon & Drews Company, of Chicago, Ill., September 23, 1899, and the work of dredging was in progress at the beginning of the fiscal year, but only a small amount of material had been excavated at that time. During the year ending June 30, 1901, good progress has been made. The number of dredges had been increased to four and preparations are being made by the contractors to add another dredge to the fleet. The daily output per dredge has been increased, thus indicating a better condition of the plant. The total amount of material excavated during the year was 961,552 cubic yards.

The work is now being so carried on as to secure first a channel of full depth and 200 feet in width throughout the entire length of the cut, after which the channel will be increased to the full width provided for by law.

A recent examination of the work already done shows that the channel is maintaining itself fairly well. In some portions an actual scour has occurred while at other places, particularly toward the inner end of the channel, there has been considerable fill. The heaviest fill of all, amounting to over 3 feet, was noticed about 2 miles outward from the mouth of the river. The character of the fill and distribution of the material indicate that it was caused by the silt brought down by the river during the spring freshets. This is a result to be reasonably anticipated, and a certain amount of periodical dredging will undoubtedly be necessary to maintain the channel. A certain amount of fill also results in the channel from material washed in from the sides of the cut. This is undoubtedly due to the action of the screws of deep-draft steamers. When the cut is made wider this fill may be less marked.

The rate of progress now being made by the contractor is such as to indicate that the work will be completed well within the time allowed. This will require a larger estimate of funds to be made this year than heretofore. In addition to the estimate under the sundry civil act, a sum for maintenance is also submitted, designed for the care, preservation, and improvement of the plant, and for operations incident to the maintenance of existing works.

The price at which the contract work is being done would indicate that the total improvement can be made well within the amount provided for by law, but it is not thought advisable at this time to attempt to reduce the estimates of the amount necessary for completion.

The commerce of the harbor shows a material increase over that of the previous year. The total freight received and shipped amounts to nearly 3,000,000 tons, an increase of more than 450,000 tons over that of 1899. There is every reason to believe that a further increase will take place as soon as the full depth of the channel can be utilized.

For a more full and detailed account of the operations at this harbor and of the results determined by recent surveys, attention is respectfully invited to the report of Assistant Engineer William T. Blunt, which is transmitted herewith.

Toledo harbor is in the collection district of Miami, Ohio. There are two lights of the sixth order at the mouth of the river, forming a range for inner portion of channel. Two iron towers have recently been completed at the turn-out in the middle of the bay, arranged to exhibit three lights, so that there is a range in both directions. There is also a light of the fourth order on Turtle Island as a guide to old channel. Under authority of Congress a new light-house is being constructed to mark the outer end of the straight channel, and assistance has been furnished the Light-House Department to locate its site. The location selected is 400 feet northwest from the axis of the straight channel, in about 21 feet of water, 21,320 feet outside the new west steel tower, measured along the axis of the channel.

Money statement.

Amount appropriated by sundry civil act approved March 3, 1901		$8,000.00
July 1, 1900, balance unexpended		243,746.55
		251,746.55
June 30, 1901, amount expended during fiscal year		108,335.04
July 1, 1901, balance unexpended		143,411.51
July 1, 1901, outstanding liabilities		16,744.50
July 1, 1901, balance available		126,667.01
July 1, 1901, amount covered by uncompleted contracts		764,786.14
Amount (estimated) required for completion of existing project		659,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901:		
For works of improvement	$250,000.00	
For maintenance of improvement of plant	30,000.00	
		280,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

Amount and date of all appropriations for improving the harbor of Toledo, Ohio.

OLD CHANNEL.

June 23, 1866	$20,000.00
March 2, 1867	20,000.00
April 10, 1869	29,700.00
July 11, 1870	50,000.00
March 3, 1871	50,000.00
June 10, 1872	15,000.00
March 3, 1873	100,000.00
June 23, 1874	75,000.00
March 3, 1875	75,000.00
August 14, 1876	60,000.00
June 18, 1878	50,000.00
March 3, 1879	$20,000.00
June 14, 1880	30,000.00
March 3, 1881	40,000.00
August 2, 1882	50,000.00
July 5, 1884	20,000.00
August 5, 1886 (see note)	9,632.61
August 11, 1888	5,000.00
September 19, 1890	5,000.00
Total for old channel	724,332.61

Appropriations for straight channel have been as follows:

July 5, 1884	$25,000.00
Deduct amount appropriated for old channel (see note)	9,632.61
	15,367.39
August 5, 1886	112,500.00
August 11, 1888	150,000.00
September 19, 1890	200,000.00
July 13, 1892	200,000.00
August 18, 1894	70,000.00
June 3, 1896	150,000.00
March 3, 1899	150,000.00
June 6, 1900	$132,500.00
March 3, 1901	8,000.00
Total for straight channel	1,188,367.39
Total of all appropriations for Toledo Harbor, Ohio	1,912,700.00
Expended to June 30, 1901	1,769,288.49
Balance unexpended July 1, 1901	143,411.51

NOTE.—By act of August 5, 1886, the balance then available of the $25,000 appropriated July 5, 1884, for straight channel was made available for clearing the old channel.

CONTRACT FOR DREDGING IN STRAIGHT CHANNEL THROUGH MAUMEE RIVER AND BAY AND FOR CONSTRUCTING A DIKE BETWEEN TURN-OUT CHANNELS, TOLEDO HARBOR, OHIO, IN FORCE DURING THE FISCAL YEAR ENDING JUNE 30, 1901.

Name of contractor: The Lydon & Drews Company, Chicago, Ill.
Date of contract: July 21, 1899.
Date of approval: September 23, 1899.
Date of commencement: May 1, 1900.
Date of completion: Continuous contract.

COMMERCIAL STATISTICS.

The following statistics for the year 1900 relative to the commerce of the harbor of Toledo, Ohio, were compiled by Wm. T. Blunt, United States assistant engineer, from information obtained from the collector of customs, shippers, and from other sources:

Receipts.	Tons.	Shipments.	Tons.
Iron ore	652,655	Corn	139,280
Coal	58,063	Wheat	53,250
Sugar	18,647	Flour	9,840
Salt	11,123	Timber	7,296
Lumber	176,378	Coal	1,547,968
Shingles	1,530	Merchandise	58,000
Lath	3,787	Oats	720
Merchandise	37,730	Total	1,816,354
Sand	203,320		
Ties	5,775		
Fish	955		
Wheat	4,665		
Corn	2,688		
Flaxseed	4,200		
Barley	586		
Total	1,182,102		

Total freight tonnage:	
1900	2,998,456
1899	2,543,069
Increase	455,387

Vessels.	Number.	Tonnage.
Entering	2,431	1,298,382
Departing	2,438	1,323,811
Built	3	3,048

Total registered tonnage (vessels entering and departing):	
1900	2,622,193
1899	2,850,872
Decrease	228,679

Draft of largest vessels using harbor, 20 feet. Largest vessels do not load to full depth. No new vessel lines established during the year.

REPORT OF MR. WM. T. BLUNT, ASSISTANT ENGINEER.

TOLEDO, OHIO, *June 30, 1901.*

SIR: I have the honor to submit the following notes upon Toledo Harbor for the fiscal year ending June 30, 1901:

All depths mentioned are given at mean level of Lake Erie, 1860 to 1875, the lake level having been about 1 foot below mean level in the fall of 1900, and about 0.6 to 0.8 foot below in the spring of 1901.

STRAIGHT CHANNEL THROUGH MAUMEE RIVER AND BAY.

Description.—A full description of the divisions of this channel for the purposes of contract, etc., was given in my annual report for June 30, 1900. In a general way it may be repeated here that the river and harbor act of March 3, 1899, provided funds for a straight channel through Maumee River and Bay 400 feet wide and 21 feet deep. At that time the existing channel was 300 feet wide from the lake to the cribs; thence 200 feet wide to the mouth of the river; thence by the natural channel of the river, in varying widths, up through the Wheeling and Lake Erie Railroad Bridge to Craig shipyard; thence through a dredged channel 400 feet wide crossing the river to the Hocking Valley wharves; thence by natural channel to Cherry Street Bridge; thence by dredged channel 400 feet wide half way to the Lake Shore and Michigan Southern Railroad Bridge, the authorized project depth throughout being 17 feet at mean level. The work under the new project was divided so that the work above the Wheeling and Lake Erie Railroad Bridge should be done by the United

States dredging plant, and that below this bridge and out through the bay should be covered by contract. The work above the Wheeling and Lake Erie Railroad Bridge was begun on May 4, 1899, and the work under continuing contract with the Lydon & Drews Company of Chicago was begun on May 1, 1900.

A map of Maumee River and Bay accompanies this report, upon which are shown the present and projected conditions in this harbor.

Work of the U. S. dredge Maumee.—At the end of the last fiscal year the United States dredge was engaged in Division A. On October 22, the dredging in this division was completed so far as seems at present necessary. From June 30 to October 22, 1900, 103,258 cubic yards of material were removed, leaving a channel 100 feet wide and upward of 21 feet deep from the deep water at Fassett Street Bridge up to the Schenck coal wharves. The material here found was exceedingly hard clay, very troublesome to dump from the scows. It was found necessary oftentimes to only partially load the scows and to load each pocket on alternate sides so as to prevent jamming of clay lumps in passing out of the scows. A great deal of delay was caused in this way and also by the necessarily long tow to the lake or bay.

From October 23 to December 12 the dredge was engaged in Division F, continuing the work begun in the fall of 1899, and 49,668 cubic yards of material were removed. The channel through this division was dredged in 1894–1897 to a depth of 19 feet, and the depths have held very well year by year. Work in the division was resumed on June 6, 1901, after the return of the dredge from Fairport Harbor, and has progressed rapidly since then, 32,070 cubic yards of material having been removed during the month of June. At the end of the fiscal year this channel had been dredged to upward of 21 feet for about half its length and two-thirds its width, with also a cut 100 feet wide through its entire length. The material is sand, mud, and silt, easily handled and dumped.

The failure of the project for a centennial exhibition at Toledo did not carry with it the failure of the construction of Bay View Park at the mouth of Maumee River, but owing to the various complications arising it was not found possible to dispose of the dredged material at the site of this park. as was indicated in my last annual report. The same contractors, however, had the contract for extending wharves between Adams and Monroe streets, so that a large amount of material dredged by the United States dredge was disposed of in this locality, to be thrown over by the contractors as filling, in the fall of 1900. In the spring of 1901 full arrangements had been made for the disposition of material at Bay View Park, but owing to the dredge being unexpectedly called to Fairport Harbor this scheme had to be abandoned and the contractors made other arrangements before the return of the dredge to Toledo. Fortunately, however, the Toledo and Ohio Central Railroad Company had contracted for the filling of Potter's pond on the east side of Maumee River, just above Cherry Street Bridge, and the contractor for that work was very glad to receive all the material that could be furnished. Almost the entire amount dredged in 1901 from Division F has been dumped for his disposal. The length of tow has thus been greatly shortened and the dredge has been able to do much better work than usual.

Following is a tabular summary of work accomplished by the dredge in Toledo Harbor during the fiscal year:

Straight channel through Maumee River and Bay.

U. S. DREDGE MAUMEE.

	Previously reported.	Fiscal year ending June 30, 1901.	Total to date.
	Cu. yds.	*Cu. yds.*	*Cu. yds.*
Division A	44,464	103,258	147,722
Division C (including Swan Creek entrance and 5,729 cubic yards commuted for logging time)	35,440	....	35,440
Division E	113,615	....	113,615
Division F	5,549	81,738	87,287
Total	199,068	184,996	384,064

Cubic yards per hour worked, season of 1900, 200. Cubic yards per hour worked, season of 1901, 192.

Work under contract, Lydon & Drews Company.—At the end of the last fiscal year progress of work under this contract had been rather small. Although the dredges, tugs, and scows were generally of large capacity, they were not in the best of condition and were not entirely adapted to the peculiar work in Maumee Bay. As the men became accustomed to the work, however, the quality and amount of work became more satisfactory. A fourth dredge was placed upon the work in August, 1900, and remained until the end of the season, November 27. During the winter a large amount of money was spent in repairing these plants, so that at the beginning of the season of 1901, on April 23, they were better equipped for the work and have been making excellent progress. At the end of the fiscal year there are four dredges working upon the contract and arrangements are being made for the placing of the fifth. The existing channel for its width of 200 feet has been deepened to upward of 21 feet as far out as the crib range in Maumee Bay, with the exception of a few hundred feet along the banks. The dredges will very soon be transferred to the lake end of the channel, and it is hoped that before the bad weather of the fall sets in the deepening will have progressed inward to a more protected location, and that by the end of the season the entire length of the channel will have been deepened to 21 feet.

In the fall of 1900 deep-laden boats experienced some difficulty in entering the channel at the outer end. Two dredges were placed there, and in September and October, 1900, opened up a cut 120 feet wide, 1,600 feet long. This work relieved the difficulty temporarily, although the cut is somewhat narrow, and some difficulty has been experienced this spring from boats grounding on the banks.

Dump grounds are located in the same general locality as before, on the east face of Cedar Point bar, though they are extended eastward, reaching deeper water, and thus materially assisting the progress of the work. Each tug captain has his own ground marked by large buoys. He is required to place each scow in regular order, and no one else is allowed in his ground. An inspector is detailed to look after this special work.

As in the previous year, contractors have been allowed to drive clusters of piles on the flats, several hundred feet away from the channel, for storage of scows when not in use, with the condition that lights be kept upon them from sunset to sunrise and that they be removed in the fall before the formation of ice. For the proper conduct of the work at the extreme outer end of the channel it is necessary to maintain three lines of stakes parallel to the channel upon the same system as on the inner channels. As these stakes are extended into deep water of the lake the contractors are required to maintain lights upon the outer stake of each line, and printed notices have been issued and widely distributed warning vessels to avoid disturbing the stakes.

The following tabular statement shows the amounts of material removed and the average capacity of each dredge. This clearly shows the results of winter repairs and of the experience gained, although the increased capacities in 1901 are partly due to shorter tow and deeper dump grounds.

Straight channel through Maumee River and Bay.

[Contract, Lydon & Drews Company, dated July 21, 1899.]

	Previously reported.	Fiscal year ending June 30, 1901.	Total to date.
	Cu. yds.	*Cu. yds.*	*Cu. yds.*
Inner division	144,999	436,301	581,300
Middle division		478,115	478,115
Outer division		47,109	47,109
Totals	144,999	961,525	1,106,524

Capacity of dredges.

	Cubic yards per hour worked.	
	May-November, 1900.	April-June, 1901.
Lydon & Drews dredge No. 1	174	216
Lydon & Drews dredge No. 8 (formerly Green No. 8)	162	209
C. H. Starke dredge No. 5	156	192
Geo. H. Breymann & Bros. Nos. 1 and 2	235	272

Comparative soundings.—In the annual report for 1898 will be found a tabular history of the straight channel from the time of its adoption, showing original depths and those found from time to time afterwards. These are tabulated so as to show changes due to dredging or natural causes during various intervals of time. For this purpose the channel is divided into longitudinal intervals of 10 feet width, and the average depth is shown in each for each section of 800 feet length. These tables were continued in reports for 1899 and 1900 and are here extended up to the present time.

Soundings have been taken as usual over the channels heretofore covered by comparison and are presented in the accompanying tables so far as it is possible to use them for the purpose. Attention has in the past been called to the fact that owing to adverse conditions of weather and various other causes these comparisons can only be accepted in a general way. It is believed, however, that the large number of soundings used to obtain the averages shown in these tables overcomes any small or accidental errors and that the tables are reliable as showing in a general way the changes occurring from year to year. The lower crossing, which constitutes division F of the 400-foot project, is omitted from the tables this year because the progress of work upon it is such that results might be misleading.

Through the inner division of the straight channel soundings were taken as soon after dredging of 1900 as practicable and again in the spring of 1901, thus showing the deposits due to that lapse of time. Through the portion of the middle division dredged in the present season it has not been possible yet to obtain soundings after dredging, but they will be shown in the next report. Over this portion comparison is made for the year previous to the dredging. Through the outer division the comparison is had for one year.

Over the inner division, dredged in 1900 to depths of 21 to 23 feet, a decided fill is shown during the past winter of 0.2 to 2 feet, averaging 1.17 feet, indicating an annual rate of from 0.2 feet to 3.54 feet, averaging 1.83 feet in different sections, and increasing with some regularity from the river mouth outward. The largest fill took place about 2 miles from the mouth of the river at the outer end of the division, and the deposits seem to be quite evenly distributed over the width of the channel. This indicates that the deposit does not come from the sides of the channel, but is brought down from above by currents, and it also emphasizes the former conclusion that a preponderance of deposit along the edges of the channel is due to action of propellers in throwing material away from the axis. There still remains generally a depth exceeding 21 feet except in one section, where the present depths are slightly less than 21 feet. Throughout this division the depths obtained by dredging generally exceeded 23 feet as a provision for partial maintenance during the progress of the contract. The only apparent cause for this large fill is the unusual ice jam in the spring of 1901, by which the water in the river was raised to 7 feet above mean level for several days. At that time of year a large amount of material is carried in suspension by the waters of the river, and the conditions were probably such that it was deposited at this particular place in the channel. This deposit is so different from what has been formerly found that it is believed to be abnormal and that it will not increase.

Over the middle division before dredging there was in every section but one a decided scour of from 0.1 to 0.3 foot, averaging 0.16 foot, indicating an annual rate of from 0.1 to 0.3 foot, averaging 0.20 foot. This scour is largely in the south half of the channel, for which no special reason is apparent. It must be noted, also, that over the outer portion of this division for 6,000 feet inside the cribs (sections 4 to 9), the tables of 1899 and 1900 also show a decided scour, so that the average present depths are actually greater than those of 1898 by from 0.2 to 0.4 foot.

Over the outer division there has been a general fill, varying from 0.1 to 0.5 foot, averaging 0.24 foot, indicating an annual rate of 0.26 foot. This fill is mostly on the sides of channel, and the mid depths usually show a scour. Depths still remain better than 18 feet, and nearly everywhere better than 19 feet.

STOREHOUSE, STORAGE BASIN, AND FLOATING PLANT.

During the winter the floating plant, consisting of the steamer *Visitor*, dredge *Maumee*, tug *Thomas Spear*, 6 dump scows, and 1 flat scow, was laid up in the storage basin at the east end of Cherry Street Bridge, as usual.

Scows.—The 4 scows which were not rebuilt during the previous winter were torn down and rebuilt in a substantial manner so that they are now stronger than originally. No. 1, built in 1894, was entirely rebuilt above water, and Nos. 4, 5, and

6, built in 1894–95, were rebuilt so far as required in their upper works. Nos. 1 and 5 were placed in dry dock in May, 1900, for completion of repairs below water.

Dredge.—As usual, steam was kept up in one boiler all winter for heating and and lighting purposes.

Boilers were cleaned, scraped, and painted.

Swinging engine was thoroughly overhauled, all bearings rebabbitted, and shaft lined up.

Main engine was raised on deck and overhauled, bearings rebabbitted, shafts lined up, including those of backing and hoisting drums.

Old bushing on backing drum was rebored and new brass bushings placed in the ends.

Main throttle valve was removed and ground to a bearing.

Entire machinery was overhauled and put in order.

Bed timbers under swinging circle and sheaves were torn out and new ones of oak were placed.

Decks and sides were patched where necessary.

Old paint in cabins was burned or scraped off and the whole repainted.

Many other minor repairs, not necessary to detail, were made as required.

Two anchor spuds, made of four 12 by 12 inch pieces each, were keyed and iron plates were set in on each side to prevent working and wearing.

Upon attempting to repair the hull of the dredge, the condition of its timbers was found to be such as to make it inadvisable to more than patch up where absolutely necessary. The condition of the hull is such that it must be practically rebuilt in order to be serviceable. The timbers are in such state of decay that a new hull should be built at the earliest possible opportunity. The machinery is in excellent condition and with a new hull of modern build it would give excellent service for many years to come. It is my opinion that a hull built of steel will cost little, if any, more than one of wood, and that it would be vastly more serviceable. It is fully justified by the condition of the machinery.

Tug.—Old tow and pawl posts were removed and new ones made and placed.

Fender strakes were torn off and renewed when necessary.

A portion of the rail was renewed.

Entire machinery was overhauled and put in order.

Boat repainted inside and outside, and many other minor repairs were made.

The condition of the hull of the tug *Spear* has become such that it is useless to attempt extended repairs, as there is little timber left sound enough to hold fastenings. Its age and general condition make it in my opinion unprofitable to attempt a rebuild. Without extensive outlay it may last a few years for light inside harbor work and should then be disposed of.

Steamer Visitor.—A few minor repairs were made upon this vessel during the winter, mostly upon the boiler. There is found to be some peculiarity in the circulation of water which induces a rapid cutting action in the legs. This action is shown even upon new work which has been in place about one year. This has been the cause of several patching jobs, and thus far neither our own men nor the boilermakers have been able to explain it.

The steel plates under the boiler, where no provision has been made for their proper care, are badly pitted and they can not be renewed without removing the boiler. By careful handling, however, it is hoped that this will cause no trouble, but it will be necessary in the near future to attend to the matter.

Considering the fact that 10 men are continuously quartered on this boat, and that it is necessary to carry a large amount of outfit, it being practically a floating office, it would be a very desirable improvement if it could be lengthened 25 feet. The quarters throughout are without exception too much contracted for comfort or utility. A special report is made upon the work done by the steamer and the party it carries.

Wharf and storehouse.—Authority having been previously obtained, an extension of 36 feet was made to the wharf at the storage basin, and a second story was added to the storehouse in which a room was fitted up for winter office. During the flood of March 12–15, 1901, the mooring piles placed in the basin were carried away by ice, but were at once replaced.

Cost of work.—The greater part of the winter repairs were done by hired labor, preference being given so far as practicable to the regular summer employees. Pay rolls for the months of December to April, inclusive, amounted to $5,310.73. This winter work was under the immediate charge of Capt. Alex. A. Stevenson, who as usual gave to it his constant and energetic care and attention.

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The following table gives the approximate cost of the different special works carried on during the winter:

	Cost.		Total.
	Material or contract.	Pay roll.	
Storehouse	$438.48	$306.08	$744.56
Wharf extension	513.10	100.17	613.27
Mooring piles	79.56	....	79.56
Visitor repairs	241.46	49.50	290.96
Dredge plant:			
Tug	346.99	127.58	474.57
Dredge (principally rebuilding dipper and repairing boom)	978.98	244.33	1,223.31
Scow No. 1	613.81	925.29	1,539.10
Scow No. 4	495.50	561.63	1,057.13
Scow No. 5	656.55	480.50	1,137.05
Scow No. 6	495.50	560.17	1,055.67
Totals	4,859.93	3,355.25	8,215.18

RULES AND REGULATIONS FOR STRAIGHT CHANNEL.

Rules and regulations for the government of the Straight channel through Maumee Bay, issued by the Secretary of War in July, 1897, as amended in September, 1899, continue to be fairly well complied with by vessel masters. It has not been necessary to officially report any vessels for infraction of the law, although several decided warnings have been issued to masters who were either ignorant of the law or careless in complying with its restrictions.

NEW LIGHT-HOUSE AND FOG SIGNAL.

At the request of Maj. T. W. Symons, Corps of Engineers, U. S. A., engineer Tenth light-house district, I was instructed by Colonel Mansfield to assist in correctly locating the site for the new light-house and fog signal to be built at the entrance to the Straight channel. On April 26 there were placed such buoys as necessary to correctly mark the site. The location is 400 feet northwest from the axis of the Straight channel, in about 21 feet of water, 21,320 feet outside the new west steel tower, measured along the axis of the channel. The location was platted upon the chart, its geodetic position determined roughly, and a full report made to Major Symons, through Colonel Mansfield. As soon as this light-house is constructed its geodetic position will be accurately determined by triangulation.

Very respectfully,

Wm. T. Blunt,
United States Assistant Engineer.

Maj. Dan C. Kingman,
Corps of Engineers, U. S. A.

Q Q 3.

IMPROVEMENT OF PORT CLINTON HARBOR, OHIO.

The location and early history of this work are briefly given upon pages 2647 and 2648, Report of Chief of Engineers, 1898, Appendix M M 3.

The protections on each side of the channel of the shore line were of a kind very cheaply constructed, because the harbor is not exposed to heavy seas, which would necessitate very strong or expensive jetties. The jetties were completed to a depth of 10 feet in the lake in 1883, which was considered as far as the conditions and necessities justified.

In 1893 and 1894 the channel was dredged to a depth of 10 feet 100 feet wide between jetties and 200 feet wide on harbor front inside of the shore line. The lake outside of the jetties is so shallow that the contour of 11 feet depth is about 1,300 feet outside the outer end of the jetties, and the contour of 12 feet depth is about 600 feet farther out than this.

To thoroughly protect a channel even out to 12 feet in the lake would require extensive jetty construction. But there is no reason to think that a channel dredged out into the lake to any desired depth of water would not be as permanent as similar channels which have been and are being dredged elsewhere under like conditions in the lake.

Since 1894 the work done at this harbor has been limited to the maintenance of the channel protection as far as could be done with the funds available, and the present project covers merely the reenforcing of the old wooden jetties by banks of small stones covered with heavy pavement.

The total amount expended to June 30, 1900, was $87,663.22.

A contract was entered into with Chas. H. Strong & Son, of Cleveland, Ohio, on October 4, 1900, for continuing the work of reenforcing the old jetties with stone in the manner above described. The work under this contract did not begin until May 18, 1901, and but little was accomplished up to the end of the fiscal year. An extension of time was granted the contractor to enable him to complete his contract.

During the year 893 tons of small stone were deposited against the jetties to form the slope, and 257.5 tons of large stone was placed over it as a pavement. Most of this work was done for the protection of east jetty. The present contract will probably cover all the work that is immediately necessary for reenforcing these jetties.

Complaints have been received from time to time of the existence of a detached bowlder on a line in prolongation of the axis of the jettied channel and some distance out in the lake, over which the depth of water is considerably less than that generally found in the channel, and a number of vessels have struck or grounded upon it. An effort will be made to discover and remove this bowlder.

Instead of doing further work upon these jetties at this time it would be quite advantageous to dredge the channel to a depth of about 12½ feet. This would require the removal of about 28,000 cubic yards of material and would cost about $7,000. An appropriation of this amount is recommended for maintenance.

The commerce of Port Clinton is not large. The total amount reported for the calendar year 1900 was 8,730 tons.

For a brief description of the work done at this harbor attention is respectfully invited to the report of Assistant Engineer William T. Blunt, which is transmitted herewith.

Port Clinton is a port of entry in the collection district of Sandusky, Ohio. The nearest light is the one recently established on outer end of west pier.

Money statement.

July 1, 1900, balance unexpended	$6,336.78
June 30, 1901, amount expended during fiscal year	455.16
July 1, 1901, balance unexpended	5,881.62
July 1, 1901, outstanding liabilities	977.21
July 1, 1901, balance available	4,904.41
July 1, 1901, amount covered by uncompleted contracts	4,461.45
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement, in addition to the balance unexpended July 1, 1901 Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	7,000.00

Amount and date of all appropriations for improving harbor at Port Clinton, Ohio.

July 10, 1872	$8,000.00	September 19, 1890	$3,000.00
July 10, 1872 (allotment)	2,000.00	July 13, 1892	[1]10,000.00
March 3, 1875	5,000.00	August 18, 1894	6,000.00
August 14, 1876	5,000.00	June 3, 1896	6,000.00
June 18, 1878	10,000.00	March 3, 1899	6,000.00
March 3, 1879	10,000.00		
June 14, 1880	5,000.00	Total	94,000.00
March 3, 1881	5,000.00	Expended to June 30, 1901	88,118.38
August 2, 1882	6,000.00		
August 5, 1886	2,000.00	Unexpended July 1, 1901	5,881.62
August 11, 1888	5,000.00		

CONTRACT FOR STONE REENFORCEMENT AND REPAIR OF JETTIES AT THE ENTRANCE TO PORT CLINTON HARBOR, OHIO, IN FORCE DURING THE FISCAL YEAR ENDING JUNE 30, 1901.

Name of contractor: Charles H. Strong & Son, Cleveland, Ohio.
Date of contract: October 4, 1900.
Date of approval: October, 27, 1900.
Date of commencement: November 1, 1900.
Date of completion: June 30, 1901; extended sixty (60) days.

COMMERCIAL STATISTICS.

The following statistics for the year 1900, relative to the commerce of the harbor of Port Clinton, Ohio, were compiled from information furnished by the collector of customs and others:

Receipts.	Tons.	Shipments.	Tons.
Coal	3,050	Fruit	2,478
Fish	400	Total	2,478
Lumber	2,350		
Logs	452		
Total	6,252		

Total freight tonnage:	
1900	8,730
1899	5,135
Increase	3,595

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[1] The river and harbor act of July 13, 1892, provided "that of the amount, $1,200 are to be paid to Charles Roose, of Oak Harbor, Ohio, in full satisfaction for the necessary portion of the sand beach adjoining the inner end of the west revetment of Port Clinton Harbor."

Vessels.	Number.	Tonnage.
Entering	85	4,627
Departing	87	5,812

Totol registered tonnage:	
1900	10,439
1899	5,420
Increase	5,019

Draft of largest vessel using harbor, 15 feet. Largest vessels do not load to full depth. No new vessel lines established during the year.

Q Q 4.

IMPROVEMENT OF SANDUSKY HARBOR, OHIO.

A brief statement of original conditions and projects of improvement is given on pages 2650 and 2651, Report of Chief of Engineers, 1898.

The report upon which the latest project was adopted and approved is in Report of Chief of Engineers, 1898, pages 2708 to 2717, with three maps, to which attention is invited.

The project of 1898 proposed an extension of the works contemplated by that of 1896, with some additions, but contains no plans nor estimates of cost for increasing the depth of channels inside of Cedar Point, which under previous project were estimated for depths of 17 feet.

For convenient reference, the project and estimate submitted February 28, 1898, are here repeated:

Extending east jetty 3,225 feet to make a total length of 5,000 feet:		
Brush mattress, 19,000 square yards, at 40 cents	$7,600	
Stone, including laying top and slopes, 54,500 tons, at $1.50	81,750	
Rough stone beacons: Two 6 feet square and 8 feet high; one 10 feet square and 12 feet high	420	
Spur from Cedar Point, brush and stone	800	
Total on east side		$90,570
Protecting crest of bar and shore of Sand Point: Sill of brush mattress 8,000 feet long, 16 feet wide, covered with stone 1 foot deep, and having a dump of stone along the middle 10 feet wide and 2 feet high, or more, and in deep water not more than 2 feet below mean lake level:		
Brush, 14,300 square yards, at 40 cents	$5,720	
Stone, 14,000 tons, at $1.50	21,000	
Three spurs on Sand Point, brush and stone	4,176	
Total for checking scour on bar		30,896
Revetment of slope (channel bank) at front range beacon:		
Brush, 6,250 square yards, at 40 cents	$2,500	
Stone, 4,840 tons, at $1.50	7,260	
Total for slope and channel bank		9,760
West dike or jetty 5,550 feet long, 10 feet wide on top, 900 feet in length raised to mean lake level, remainder to a plane 3 feet below mean lake level. Mattresses to project 6 feet beyond foot of slopes, and projecting part to be covered with stone 1 foot deep:		
Brush mattresses, 30,300 square yards, at 40 cents	$12,120	
Stone, 80,000 tons, at $1.50	120,000	
Rough stone beacons: Four 6 feet square and 8 feet high, and 1 10 feet square and 12 feet high	500	
Total for west jetty		132,620

Deflecting dike for inner bar, 1,500 feet long, 10 feet wide on top, and top 2 feet below mean lake level, on brush mattress, as in west dike:

Brush, 10,000 square yards, at 40 cents	$4,000	
Stone, 33,300 tons, at $1.50	49,950	
Total		$53,950
For all works of construction		317,796

The previous project included extending the east jetty to a length of 2,500 feet, and making a dike of same length on west side. Also to dredge channel over bar 18 feet deep and 200 feet wide, and complete inside channels to width of 200 feet and depth of 17 feet. Estimate for completion in 1898 was $185,000.

See pages 2651 and 2652, Report of Chief of Engineers, 1898.

The later project made no modification in the estimate previously submitted for dredging, but covered the incomplete work of construction on the jetty and dike which was included in former project and estimated to cost $77,000. The increase of cost over estimate for project of 1896 is therefore:

$317,796—$77,000	$240,796
Estimated to complete project of 1896	185,000
Total of estimate for project of 1898	425,796

At the beginning of the fiscal year 1901 dredging was in progress under contract with E. J. Pryor, of Houghton, Mich. This contract was completed by the exhaustion of funds in October, 1900; 200,289 cubic yards of material having been removed in all, of which 74,579 cubic yards was dredged in the present fiscal year. In addition to this the United States dredge removed 27,355 cubic yards of material.

Work of jetty construction was also in progress under contract with Patrick Keohane, of Fayetteville, N. Y., at the beginning of the fiscal year. This contract was also closed by the exhaustion of funds October 22, 1900. At that time there had been completed under the contract 1,338 feet of the east jetty, of which 1,018 feet were built during the fiscal year. The total completed length of the east jetty is now 3,113 feet, measured outward from the shore. There is an additional portion, about 223 feet in length, which is only partially completed. The spur dike extending outward from Cedar Point across the flats to the "Deep Hole" has been completed for its full length and sand appears to be rapidly accumulating against it.

The act of Congress approved June 6, 1900, called for an examination of the harbor of Sandusky, Ohio, "with a view to obtaining and maintaining a channel 21 feet deep at mean lake level, with a width of 400 feet in the approaches to the harbor front and 300 feet in the harbor channels."

This examination was made under the direction of Col. Jared A. Smith, Corps of Engineers, and his report, dated August 22, 1900, was published as House Doc. No. 120, Fifty-sixth Congress, second session. No action has yet been had by Congress upon this report.

Colonel Smith's report presents a complete and comprehensive project for the improvement of the harbor of Sandusky in accordance with modern conditions and requirements, so as to make it a first-class lake harbor. I am of the opinion, however, that the rock excavation provided for in the project can be accomplished at a cost considerabl less than the estimate, and that the cost of the whole work in con quence will be materially reduced.

The commerce of Sandusky is increasing, and would no doubt increase more rapidly if the depth in the channels was made that of a first-class lake harbor. The total freight tonnage for 1900 amounted to about a million and a quarter tons, an increase of 100,000 tons over that of the preceding year.

In the financial statement, which follows, the estimates submitted for the completion of the work and for economical expenditure during the coming fiscal year are necessarily based upon the existing project. If the new project is adopted, then the amount which can be profitably expended should be increased at least to $200,000.

For a detailed description of the work done during the present fiscal year, and for a full report upon the existing conditions at the harbor at Sandusky, attention is respectfully called to the report of Assistant Engineer William T. Blunt, which is transmitted herewith:

Sandusky Harbor is in the collection district of Sandusky, Ohio. There is a lighthouse on Cedar Point with a white light of the fifth order, and a range beacon to mark the channel over outer bar. Two range lights mark the axis of straight channel, and two beacons have been completed to mark new channel over outer bar. The latter were first lighted on opening of navigation, 1900.

Money statement.

July 1, 1900, balance unexpended		$46,275.71
June 30, 1901, amount expended during fiscal year		45,314.65
July 1, 1901, balance unexpended		961.06
July 1, 1901, outstanding liabilities		173.00
July 1, 1901, balance available		788.06
Amount (estimated) required for completion of existing project		345,796.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901:		
For works of improvement	$150,000.00	
For maintenance of improvement	10,000.00	
		160,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

Amount and date of all appropriations for improving harbor at Sandusky, Ohio.

June 11, 1844	$15,000.00
August 30, 1852	15,000.00
June 28, 1864 (allotment)	10,000.00
June 23, 1866	38,580.00
July 11, 1870	10,000.00
June 10, 1872	13,000.00
March 3, 1873	25,000.00
June 23, 1874	25,000.00
March 3, 1875	25,000.00
August 14, 1876	25,000.00
June 18, 1878	20,000.00
March 3, 1879	1,000.00
July 14, 1880	12,500.00
March 3, 1881	10,000.00
August 2, 1882	$10,000.00
July 5, 1884	20,000.00
August 5, 1886	5,000.00
August 11, 1888	40,000.00
September 19, 1890	45,000.00
July 13, 1892	41,712.00
August 18, 1894	30,000.00
June 3, 1896	40,000.00
March 3, 1899	80,000.00
Total	556,792.00
Expended to June 30, 1901	555,830.94
Unexpended July 1, 1901	961.06

LIST OF CONTRACTS FOR IMPROVING HARBOR AT SANDUSKY, OHIO, IN FORCE DURING THE FISCAL YEAR ENDING JUNE 30, 1901.

Contract for dredging.

Name of contractor: E. J. Pryor, Houghton, Mich.
Date of contract: May 22, 1899.
Date of approval: June 12, 1899.
Date of commencement: July 15, 1899.
Date of completion: July 15, 1900.

Contract for constructing works of brush and stone near Cedar Point.

Name of contractor: Patrick Keohane, Fayetteville, N. Y.
Date of contract: May 22, 1899.
Date of approval: June 16, 1899.
Date of commencement: July 15, 1899.
Date of completion: November 1, 1900.

COMMERCIAL STATISTICS.

The following statistics for the year 1900, relative to the commerce of the harbor of Sandusky, Ohio, were compiled from information furnished by the collector of customs and others:

Receipts.	Tons.	Shipments.	Tons.
Iron ore	184,260	Coal (bituminous)	755,004
Pig iron	11,717	Merchandise	19,359
Grain	17,971	Sand	19,000
Lumber, lath, shingles, cedar posts, and ties	71,054	Total	793,363
Pulp wood	15,777		
Sand	170,192		
Salt	8,575		
Fish	8,501		
Merchandise	17,610		
Fruit	6,980		
Stone	15,122		
Wine	8,260		
Plaster and lime	1,008		
Total	472,007		

Total freight tonnage:	
1900	1,265,370
1899	1,164,172
Increase	101,198

Vessels.	Number.	Tonnage.
Entering	4,615	1,287,466
Departing	4,897	1,283,660
Built	1	29 net.

Total registered tonnage (vessels entering and departing):	
1900	2,571,126
1899	2,510,259
Increase	60,867

Draft of largest vessels using harbor, 18 feet. Largest vessels do not load to full depth. No new vessel lines established during the year.

NOTE.—Vessels do not load to their maximum draft because the ruling depth in the harbor is in accordance with the 17-foot project. Recent acts of Congress have made 21 feet the standard depth for lake channels and hence every first-class harbor must permit this draft.

REPORT OF MR. WM. T. BLUNT, ASSISTANT ENGINEER.

TOLEDO, OHIO, *June 30, 1901.*

SIR: I have the honor to submit the following notes upon Sandusky Harbor, Ohio, for the fiscal year ending June 30, 1901:

All depths mentioned are given at mean level of Lake Erie, 1860 to 1875, the lake level having been about 1 foot below mean level in the fall of 1900, and about 0.6 to 0.8 foot below in the spring of 1901.

DREDGING UNDER CONTRACT, E. J. PRYOR.

At the beginning of the fiscal year, work of dredging the channels was in progress under the contract of E. J. Pryor, dated May 22, 1899. This contract was completed by exhaustion of funds on October 10, 1900, after the removal of 200,289 cubic yards of material by the contract dredge, of which 74,579 cubic yards were removed during the fiscal year, and of 27,355 cubic yards of material by the United States dredge *Maumee*, the cost of which was charged to this contract. There were also allowed ninety-five hours forty-seven minutes, logging time, for removal of bowlders, etc., of which thirty-three hours forty minutes were allowed during the fiscal year.

Outer bar.—In September, 1900, the Pryor dredge was placed at the extreme lake end of the outer channel to remove the only shoal place which appeared to be troublesome to navigation. Three cuts of varying lengths were taken through this locality, the amount of material removed being 4,050 cubic yards. This relieved the difficulty and left the outer channel in excellent condition throughout.

Straight channel.—The cuts made by the Pryor dredge in the fall of 1899 along the axis of the Straight channel had preserved their depths very well, but the shoal water at the sides of these cuts caused considerable difficulty during the summer of 1900. In July and August, 1900, the dredge was, therefore, again placed in the Straight channel and one additional cut on the west side was taken through five sections and an additional cut on the east side through three sections.

Through heavily laden boats attempting to pass the channel in low water a very serious shoaling took place at the outer end of the Straight channel in the fall of 1900, and in October three cuts were made through this locality for about 800 feet in length. The total amount of material removed from the Straight channel during the fiscal year was 31,456 cubic yards.

Dock channel.—Through the Main Dock channel two cuts were taken for the entire length and a third cut for a length of about 600 feet at the west end. These cuts passed over the same ground dredged many times previously, and no attempt was made to widen the channel. The total amount of material removed from this section was 28,505 cubic yards, all during the fiscal year.

West Section Dock channel.—In this section of the Dock channel, heretofore known as the "Short Line" extension the dredge was at work at the beginning of the fiscal year. This work was continued until about the middle of July and again for a few days in September, resulting in a channel at least 80 feet wide up to the west wharf of the Columbus, Sandusky and Hocking Railroad Company. The amount of material removed from this section during the fiscal year was 10,568 cubic yards.

BOWLDERS.

The work of dredging under the Pryor contract uncovered a large number of bowlders, some of which were removed intact by the dredge but many of which were too large to be handled. These were disposed of by blasting under the supervision of the inspector of dredging, for which purpose two boatmen were employed. During the progress of the contract there were removed in this way 123 bowlders at a cost of $791.68, of which 44 were removed in the fiscal year at an expense of $435.49.

JETTY WORK UNDER CONTRACT, PATRICK KEOHANE.

At the beginning of the fiscal year the work of jetty construction under contract of Patrick Keohane, dated May 22, 1899, was in progress. The contract was closed by exhaustion of funds on October 22, 1900. At that time there had been built under this contract 1,338 feet of east jetty, of which 1,018 feet were built during the fiscal year. The outer end of the completed jetty is now 3,113 feet from shore, measured along the jetty, and there is an extension of uncompleted work 223 feet farther, 76 feet being covered with stone to within 5 feet of mean lake level, 86 feet to within 8 feet, and 61 feet to within 11 feet. The depth of water at the outer end of this jetty is now 15½ feet, with no indication of scour.

Nothing has been done upon the west jetty during the fiscal year.

The spur dike from Cedar Point across the flats to the "deep hole" has been completed for its full length, and sand appears to be rapidly accumulating around it.

The sill running westward from the Straight channel front light, which was found in June, 1900, to have been damaged by ice, was repaired and extended to a total length of 801 feet, with an additional length of 200 feet covered with hand stone.

During the fiscal year ending June 30, 1901, there was placed under this contract 7,582.8 tons of riprap stone, 16,744.4 tons of hand stone, 7,793.6 square yards of brush mattress.

Examination in the spring of 1901 showed the entire work to be in very good condition, except that one pile at the outer end of the incomplete portion of the east jetty was gone.

EXAMINATION FOR NEW PROJECT.

For the purpose of complying with the provisions of the emergency river and harbor act of June 6, 1900, an examination was made in August and September, 1900, of the inner channels to determine the depth to rock bottom. Borings were taken with a steel rod at various places in the Straight channel and along the entire Dock channel as now dredged. They were also taken on the prolongation of the Main Dock channel with a view to projecting this channel in a straight line under the proposed new project, thus avoiding the two bends now existing between the main wharves and the Columbus, Sandusky and Hocking Railroad Company wharves. The only solid rock found above the grade of 21 feet below mean level was at the west end of the Main Dock channel, where for a length of about 1,100 feet solid rock was found at depths varying from 18 to 21 feet. Upon this examination a special report was made to Colonel Smith, under date of October 29, 1900, in which it was proposed and recommended that the Dock channel under the new project be extended westward without change of direction.

WRECK OF SCHOONER "BENSON."

At the beginning of the fiscal year the wreck of the schooner *Benson*, lying off the entrance to Sandusky Harbor, had not been entirely removed. It was not until September 1, 1900, that a final report was made to the officer in charge that the locality was clear of wreckage.

RULES AND REGULATIONS FOR CHANNELS.

The rules and regulations for the government of the channels in and about Sandusky Bay, Ohio, issued by the Secretary of War on January 6, 1899, as amended September 29, 1899, are generally fairly well complied with. No vessel masters have yet been officially reported, although several have been very sharply warned.

CONDITION OF CHANNELS AND COMPARATIVE SOUNDINGS.

An extra set of soundings over the entire channels was taken in October, 1900, and the regular examinations were made in June, 1901, over the outer bar and Straight channel.

Cedar Point and outer channels.—The soundings of October, 1900, and of June, 1901, show only very slight changes. The general characteristics have remained practically the same since the partial opening of the new range in the fall of 1899. The steep bank on the west edge of the cut, even where it passes the crest of the bar, remains practically as dredged. In only two places is there any decided advance of the contours into the channel, and these are so slight as to give no indication of a general tendency in that direction. At the lake end of the channel there seems to be a tendency to scour on the line of the new range, probably due to the influence of the extended jetty on the east and the straightened bank parallel to it on the west. The least depth along the axis of the channel as lighted is 18 feet, and this is only in two places of very small area, most likely formed by the action of propeller wheels when vessels were aground during low water. The shoalest place now is on the outer range just inside its junction with the Cedar Point range, where there is less than 19 feet at mean level entirely across the channel for a length of about 150 feet, and less than 20 feet for a length of 400 feet. For considerably more than half the length of the channel there is a depth of over 20 feet for varying widths from 50 to 200 feet.

Straight channel.—Mid depths in the Straight channel are greater than 18 feet at mean level, except near its inner end, where they are still greater than 17½ feet. The 17-foot depth is 130 feet wide at the inner end for about 800 feet of length; it is

150 feet wide for 3,000 feet of length, and varies from 150 to 200 feet over the balance of the channel.

In nearly all sections more or less dredging was done in 1900, so that the tabular comparisons for the year must be made upon the soundings of October, 1900, and June, 1901, only. During that period a resultant fill has taken place in all sections, except No. 3, averaging for the channel 0.18 foot and indicating an average annual rate of 0.27 foot. The distribution of this deposit is irregular and shows no points of special interest for discussion.

Dock channel.—No regular examination was made of the Dock channel this season, but the soundings of October, 1900, showed it to be in excellent condition in the areas dredged, as mentioned above. Depths were everywhere better than 18 feet, and over a large portion were 19 and 20 feet. This portion of the channel is very narrow and the trouble from this source is enhanced by the continued low stage of water and by the presence of occasional bowlders, some of which may have been missed in the dredging of the channel and some of which may have rolled in from the banks after the dredging was completed. Very little trouble has been experienced this season, however, because vessel owners are beginning to realize that vessels should be loaded according to the depth of water actually in a harbor, rather than to the limit of the boat's capacity, and have therefore loaded generally to about 16½ feet for Sandusky Harbor.

In general.—There is great need of extensive dredging in the channels if the harbor is to be placed upon a modern basis. The project depth of 17 feet in inner channels and 18 feet in outer channels is actually in existence, though not for the full width in the Straight channel or Dock channel. Even for the present project 16,000 cubic yards of material should be removed from outer bar in order to make the new range lights fully available to the lake, and 260,000 cubic yards should be removed from the inner channels to give full width, all amounting to not less than $40,000.

Should Congress see fit to make the same change in project as was set forth in the last river and harbor bill, which failed of passage, it is respectfully urged that not less than $200,000 should be made at once available in order to obtain results of any general use.

Very respectfully,

WM. T. BLUNT,
United States Assistant Engineer.

Maj. DAN C. KINGMAN,
Corps of Engineers, U. S. A.

Q Q 5.

IMPROVEMENT OF HURON HARBOR, OHIO.

A brief statement of the early condition of the harbor at the mouth of the Huron River and of the projects for its improvement is given on pages 2653 and 2654, Report of the Chief of Engineers, 1898. (Appendix M M 5.)

The latest project of improvement was adopted in 1890. It contemplated the extension of the parallel piers, 140 feet apart, to the general contour of 16 feet depth in the lake. This involved an extension of 720 feet to the east pier and 760 feet to the west pier.

The estimated cost, revised in 1893, for amount then remaining to be constructed was $125,000.

Since the adoption of the project the east pier has been extended 152 feet and the west pier 160 feet, leaving for east pier 568 feet and for west pier 600 feet to be constructed under the project. The last extension to piers was in 1895.

The size of vessels carrying heavy freights on the lakes has been very radically increased since the adoption of the project for this improvement, so that a depth of 20 feet at mean lake level is essential in order to have a sufficient depth for heavily loaded vessels during the stages of low water which regularly occur, to a greater or less extent, toward the close of every season of navigation. No harbor having a depth not more than 16 feet can now be considered even to a small extent as a port for receiving and shipping heavy freights. It is too evident to require remark that freights can not be successfully carried in channels where the depth is less than the draft of loaded vessels. Small vessels are rapidly disappearing from the carrying of freights on the lakes, and it follows that harbors which can not secure the necessary depths for large vessels can not fail to lose the tonnage and importance which they held in earlier days under different conditions.

The foregoing remarks have been introduced to explain in part why the officer in charge of the improvement does not recommend a further extension of the piers under the plans and limitations of the project of 1900.

The estimated cost of completing the project as presented in the last annual report was $117,500. This is the unexpended balance of the estimate for construction only, as revised in 1893, after completing work then under contract. At prices which then obtained the amount estimated would be sufficient to cover the completion of the work as proposed in 1890. The recent advance in prices and the great difficulty of procuring suitable timber have, however, made necessary the introduction of new methods and materials in construction, and the estimates of cost based upon former conditions are no longer sufficient.

As the completion of the project of 1890 on the lines then considered sufficient are now entirely inadequate to provide for existing conditions, it is not deemed necessary nor desirable to revise and thus increase the estimate of its cost. It is therefore explained that the estimate for completion of the project as given in money statements is merely the former estimate brought forward without change or revision on account of increased prices and the resulting change in methods of construction.

It was not thought advisable to expend the $25,000 appropriated by the act of March 3, 1899, in extending the piers under existing conditions, and its expenditure was authorized for the purpose of removing and renewing a portion of the west pier. It was proposed to do this work under contract, and the design of the new portion was to be the same as that adopted for improving the harbor of Lorain, Ohio; that is to say, it was to consist of a crib substructure with a concrete top.

A contract was entered into with I. R. Churchyard, of Buffalo, N. Y., and was approved by the Chief of Engineers October 13, 1900, for the execution of this work. The terms of the contract required the work to be commenced on or before April 1, 1901, but the contractor made no preparations to begin the work at the appointed time, and some time subsequently at his own earnest desire the contract was annulled by the Chief of Engineers April 25, 1901. Authority was then granted to execute the work by hired labor. Arrangements have been made for the purchase of the necessary materials and some of it has already been shipped.

The plan and construction was so far modified as to permit the use of a timber superstructure instead of a concrete one, as the total concrete work to be done was too small to justify the purchase or hire of a concrete-making plant.

The commerce of Huron Harbor consists almost exclusively of the receipt of iron ore and the shipment of coal. The total of these commodities received and shipped in the year 1900 was 656,179 tons, an increase of over 45 per cent over the largest amount heretofore reported.

The oldest parts of piers at Huron were constructed in 1826 or 1827, and the latest portions were constructed in 1896.

On the west side a length of 340 feet, which has been built within a few years, is in fairly good condition, but needs some repairs to plank of deck. Two parts of west pier, a total length of 828 feet, have had the superstructure rebuilt within a few years, but the substructure is in bad condition, so that in case of a general repair it would be better to remove it with other parts which ought to be rebuilt, making a total length of 1,180 feet on west side.

On the east side a length of 152 feet, built in 1893 and 1895, is in fairly good condition, but the remainder of pier, a length of about 720 feet, is in such bad condition that it should be rebuilt.

The latest designs for piers with superstructure of concrete are estimated to cost about $120 per linear foot. The length of pier which will remain to be rebuilt after the expenditure of funds now available will be 1,000 feet on west side and 720 feet on east side. Estimated cost of 1,720 feet of pier, at $120 per foot, $206,400.

Huron Harbor is in the collection district of Sandusky, Ohio. There is a fixed white light of the fourth order on the outer end of the west pier.

Money statement.

July 1, 1900, balance unexpended	$25,000.00
June 30, 1901, amount expended during fiscal year	240.69
July 1, 1901, balance unexpended	24,759.31
July 1, 1901, outstanding liabilities	15.10
July 1, 1901, balance available	24,644.21
Amount (estimated) required for completion of existing project	117,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement, in addition to the balance unexpended July 1, 1901	50,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

Amount and date of all appropriations for improving harbor at Huron, Ohio.

May 20, 1826	$5,000.00	June 14, 1880	$3,000.00
May 19, 1828	4,413.35	March 3, 1881	3,000.00
March 3, 1829	5,935.00	August 2, 1882	2,500.00
April 23, 1830	1,880.36	July 5, 1884	7,500.00
March 2, 1831	3,480.00	August 5, 1886	3,000.00
July 3, 1832	1,500.00	August 11, 1888	6,000.00
June 28, 1834	6,700.00	September 19, 1890	16,000.00
June 2, 1836	4,300.00	July 13, 1892	15,000.00
March 3, 1837	2,565.00	August 18, 1894	10,000.00
July 7, 1838	5,000.00	June 3, 1896	8,000.00
June 11, 1844	5,000.00	March 3, 1899	25,000.00
August 30, 1852	10,000.00		
June 23, 1866	39,000.00	Total	197,273.71
June 23, 1874	1,500.00	Expended to June 30, 1901	172,514.40
March 3, 1875	1,000.00		
June 18, 1878	1,000.00	Unexpended July 1, 1901	24,759.31

CONTRACT FOR REMOVING AND REBUILDING PART OF WEST PIER, HARBOR AT HURON, OHIO, IN FORCE DURING THE FISCAL YEAR ENDING JUNE 30, 1901.

Name of contractor: I. R. Churchyard, Buffalo, N. Y.
Date of contract: August 22, 1900.
Date of approval: October 13, 1900.
Date of commencement: April 1, 1901.
Date of completion: September 30, 1901.
Date of annullment: April 25, 1901.

COMMERCIAL STATISTICS.

The following statistics for the year 1900 relative to the commerce of the harbor of Huron, Ohio, were compiled from information received by the collector of customs and others:

Receipts.	Tons.	Shipments.	Tons.
Iron ore	360,544	Coal (bituminous)	295,635

Total freight tonnage:	
1900	656,179
1899	No report.

Vessels.	Number.	Tonnage.
Entering	214	220,537
Departing	194	242,405

Total registered tonnage:	
1900	462,942
1899	No report.

Draft of largest vessels using harbor, 18 feet. No new vessel lines established during the year.

NOTE.—The mouth of the river had a bar form across it towards the fall, but for a temporary obstruction vessels can enter and clear drawing 18 feet.

Q Q 6.

IMPROVEMENT OF VERMILION HARBOR, OHIO.

For a description and brief history of this improvement see page 2696, Report of Chief of Engineers, 1898.

No appropriation was made for this work in the river and harbor act of March 3, 1899, and as no funds were available the work was not mentioned in the last annual report for this district.

When last examined, in 1897, the minimum depth through the jettied channel was found to be not less than 11 feet, and not less than 12 feet thence outward to the lake. Some portions of the jetties were in fairly good condition, but by far the greater part was in a state of utter decay above the mean level of the lake, and considerable stone had been washed out of the cribs.

It was estimated by the officer then in charge of the improvement that about 1,600 feet of jetty would have to be renewed in order to restore the harbor to its original condition, and that the least cost of this work would be $50,000. He was of the opinion that the commercial importance of the harbor would not justify such an expenditure.

In December, 1900, a complaint from a citizen of Vermilion, Ohio, was forwarded through his member of Congress to the Chief of Engineers to the effect that the waves, resulting from a severe storm, had broken around the shore end of the east jetty and had scoured out a channel of considerable width from the lake through into the jettied channel, and that a large quantity of material was thus being washed into the channel, threatening to completely close it up. Immediate action to prevent further injury was strongly urged.

Accordingly an allotment was made by the Chief of Engineers of of $1,500 from the appropriation for "Emergencies in river and harbor works," act of June 9, 1900, for repairs to the east breakwater at Vermilion Harbor, Ohio, the intention being that it should be applied to the work of repairing the damage done by the storm. Temporary work was at once undertaken, and the break was closed at a cost of $176.27. The balance of the allotment is still held in order to determine what further work, if any, is necessary to complete the repairs for which the allotment was made.

A copy of the letter[1] asking for the allotment is transmitted herewith, together with the report[1] of Assistant Engineer William T. Blunt, describing the injury and the method of repairing it.

In view of future contingencies of this character, which are very certain to occur if the harbor is left in its present condition, it seems important that the attitude of the United States toward this harbor in reference to future appropriations should be definitely determined. If the harbor is to be wholly abandoned, then no further attention need be paid to applications for temporary repairs; but if the United States intends to preserve the harbor, provisions should be made before it is too late to restore it at least to its former condition.

It may be said that the United States has already appropriated and expended upon this harbor the sum of $132,701.28, not including this last expenditure resulting from the injury due to the storm.

The letter of Mr. Coen, of Vermilion, would seem to indicate that the harbor is at least of local value, and that it possesses a certain amount of commerce; and its condition, so far as it is known to this office, would indicate that it was naturally as good as any of the other small harbors in the district.

Vermilion is in the collection district of Sandusky, Ohio. There is a fixed light of the fifth order on the west pier.

Money statement.

December 21, 1900, allotment from emergency river and harbor appropriation, act of June 6, 1900	$1,500.00
June 30, 1901, amount expended during fiscal year	176.27
July 1, 1901, balance unexpended	1,323.73

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[1] Not printed.

Amount and date of all appropriations for improving harbor at Vermilion, Ohio.

July 2, 1838	$10,000.00
March 3, 1837	20,000.00
July 7, 1838	23,626.57
June 28, 1864 (allotment)	5,758.97
June 23, 1866	15,315.74
June 10, 1872	5,000.00
March 3, 1873	12,000.00
June 23, 1874	3,000.00
March 3, 1875	10,000.00
August 14, 1876	5,000.00
June 18, 1878	4,000.00
June 14, 1880	2,000.00
March 3, 1881	2,000.00
August 2, 1882	3,000.00
August 5, 1886	$3,000.00
August 11, 1888	1,000.00
September 19, 1890	2,000.00
July 13, 1892	2,000.00
August 18, 1894	2,000.00
June 3, 1896	2,000.00
June 6, 1900 (allotment)	1,500.00
Total	134,201.28
Expended to June 30, 1901	132,877.55
Unexpended July 1, 1901	1,323.73

Q Q 7.

IMPROVEMENT OF BLACK RIVER (LORAIN) HARBOR, OHIO.

A statement regarding location, conditions, and projects for improvement of this harbor is given upon page 2658, Report of Chief of Engineers, 1898.

The present project was adopted in 1894, and provides for the renewal of piers, construction of breakwaters converging toward the lake, and the dredging of protected channels and areas to a full depth of 20 feet. The improvement was authorized to be undertaken by continuous contract by the river and harbor act of March 3, 1899, but when proposals were invited the estimate was found to be insufficient, this being due to the increase in the cost of labor and material which had resulted during the interval since the estimate was made.

The act of June 6, 1900, authorized a contract to be made for a portion of the proposed improvement up to the limit of the amount allowed, provided no portion of the work should cost more than a 10 per cent increase over that in the first estimate. This law permitted a contract to be made providing for the renewal of the piers as far as was necessary, the construction of pier heads of the breakwater, and the completion of the west breakwater 1,800 feet in length, as well as for all necessary dredging between the jetties. It left the east breakwater, 1,500 feet in length, unprovided for.

The style of construction adopted for the breakwaters required them to be constructed wholly of stone of the approved design, the pier heads alone to be constructed of timber cribs below water and concrete caps above. The jetties are to be of timber below water, with a concrete superstructure.

A separate contract was made with Edward J. Hingston, of Buffalo, N. Y., for dredging a channel between the jetties and at the entrance to them so as to provide a depth of at least 20 feet below mean lake level. Operations under this contract were in progress at the beginning of the present fiscal year, and were continued until September 9, 1900. A total of 108,757 cubic yards of material was removed under this contract. Of this amount, 41,974 cubic yards were removed during the present year.

The contract for the construction of the jetties and the west breakwater was made with Patrick Keohane, of Fayetteville, N. Y., in October, 1900. He was required to begin the work not later than April 1, 1901. He made a technical compliance with the contract by beginning the work on a very small scale, but besides the collection of building material little work was done during the fiscal year.

The city and harbor of Lorain are not generally known by the name of the small stream for the improvement of which appropriations have been made. The name of the stream has been used in all river and harbor acts, except the emergency act of June 6, 1900, where it was designated as "Lorain Harbor, Ohio." This designation is now preferable.

The estimated cost of building the east breakwater of stone is $190,000, which, added to the amount already authorized, makes the entire estimate $705,350. In addition to this, a moderate sum should be available at any time for maintenance and dredging.

The commerce of the harbor of Lorain shows a constant increase. The receipts and shipments for the year 1900 amounted to more than one and a half million tons, an increase of nearly 125,000 tons over that of the previous year.

For a description of the work done during the present fiscal year, attention is respectfully invited to report of Assistant Engineer G. T. Nelles, which is transmitted herewith.

Black River (Lorain) Harbor is in the collection district of Cuyahoga, Ohio. There is a fixed white light of the fourth order on the outer end of west pier and a beacon on the inner end of west pier to form a range for entering the harbor.

Money statement.

July 1, 1900, balance unexpended		$166,604.42
June 30, 1901, amount expended during fiscal year		10,142.49
July 1, 1901, balance unexpended		156,461.93
July 1, 1901, outstanding liabilities		138.25
July 1, 1901, balance available		156,323.68
Amount (estimated) required for completion of existing project		530,350.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901:		
For works of improvement	$300,000.00	
For maintenance of improvement	10,000.00	
		310,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

Amount and date of all appropriations for improving harbor at Black River, Ohio.

May 23, 1828	$7,500.00
April 23, 1830	8,559.77
March 2, 1831	9,275.00
July 3, 1832	8,000.00
March 2, 1833	2,400.00
June 28, 1834	5,000.00
March 3, 1835	4,400.00
July 2, 1836	6,660.00
March 3, 1837	6,410.00
July 7, 1838	5,000.00
August 30, 1852	5,000.00
June 28, 1864 (allotment)	20,000.00
June 23, 1866	10,000.00
June 10, 1872	20,000.00
March 3, 1873	20,000.00
June 23, 1874	20,000.00
March 3, 1875	10,000.00
August 14, 1876	6,000.00
June 18, 1878	1,000.00
June 14, 1880	$1,000.00
March 3, 1881	7,000.00
August 2, 1882	7,000.00
July 5, 1884	10,000.00
August 5, 1886	10,000.00
August 11, 1888	10,000.00
September 19, 1890	12,000.00
July 13, 1892	20,000.00
August 18, 1894	10,000.00
June 3, 1896	30,000.00
March 3, 1899	50,000.00
June 6, 1900	125,000.00
Total	467,204.77
Expended to June 30, 1901	310,742.84
Unexpended July 1, 1901	156,461.93

LIST OF CONTRACTS FOR IMPROVING HARBOR AT BLACK RIVER (LORAIN), OHIO, IN FORCE DURING THE FISCAL YEAR ENDING JUNE 30, 1901.

Contract for dredging.

Name of contractor: Edward J. Hingston, Buffalo, N. Y.
Date of contract: October 17, 1899.
Date of approval: October 2, 1899.
Date of commencement: November 9, 1899.
Date of completion: September 9, 1900.

Contract for constructing west breakwater, two pierheads, and removing and rebuilding parts of east and west piers.

Name of contractor: Patrick Keohane, Fayetteville, N. Y.
Date of contract: October 27, 1900.
Date of approval: November 22, 1900.
Date of commencement: April 1, 1901.
Date of completion: Continuous contract.

COMMERCIAL STATISTICS.

The following statistics for the year 1900 relative to the commerce of the harbor at Black River (Lorain), Ohio, were compiled from information furnished by the collector of customs and others:

Receipts.	Tons.	Shipments.	Tons.
Iron ore	1,103,962	Coal	402,662
Lumber, lath, etc	15,118	Billets (steel)	1,055
Stone	450	Rails (steel)	18,350
Sand	1,750	Dynamite	1
Pig iron	1,369		
Billets (steel)	1,500	Total	422,068
Ice	490		
Fruit	2		
Total	1,124,641		

Total freight tonnage:	
1900	1,546,709
1899	1,423,157
Increase	123,552

Vessels.	Number.	Tonnage.
Entering	489	773,315
Departing	485	751,650
Built	8	20,569

Total registered tonnage (vessels entering and departing):	
1900	1,524,965
1899	1,385,286
Increase	139,679

Draft of largest vessels using harbor, 18½ feet. Largest vessels do not load to full depth. No new vessel lines established during the year.

REPORT OF MR. G. T. NELLES, ASSISTANT ENGINEER.

CLEVELAND, OHIO, *June 30, 1901.*

MAJOR: I have the honor to submit the following report of operations at Black River (Lorain) Harbor, Ohio, for the fiscal year ending June 30, 1901:

My connection with this improvement has been so brief that this report is necessarily a compilation of information gathered from the records of the Cleveland office and from the inspectors and others familiar with the conditions in the harbor.

At the end of the last fiscal year work was being prosecuted under a contract with Edward J. Hingston, of Buffalo, N. Y., for dredging in the channel between the piers and in the entrance to the channel, so as to provide a depth of at least 20 feet below mean lake level. Operations were continued under this contract until September 9, 1900. A total of 108,757 cubic yards of material was removed under the contract. Of this amount, 41,974 cubic yards were handled during the present fiscal year. The survey made on May 8, 1901, shows a depth of more than 21 feet below mean lake level over the whole area dredged in 1900, and clearly indicates the favorable conditions in this respect at Black River Harbor.

The storms of November, 1900, caused a breach in the superstructure of the east pier, which rapidly widened until it finally included fully 600 feet of the work constructed prior to 1891. The depth of the breach is from 2 to 6 feet, and while the seas sometimes run through it no serious inconvenience or damage has yet resulted.

Under date of September 9, 1900, proposals were invited for constructing the west breakwater and removing and rebuilding part of the east and west piers, in accordance with the approved project for the improvement of this harbor, dated November 1, 1897, and designated as Plan "B" (House Doc. No. 131, Fifty-fifth Congress, second session). Bids were received for two types of breakwater, the first to be entirely of stone, of the form and construction advised in the report of the Board of Engineer officers appointed October 6, 1897, to consider and report upon the subject of breakwater construction at Black River and other harbors; the second type consisted of a structure composed of stone-filled timber cribs, with concrete superstructure, resting on a foundation of small stone, and protected against undermining by suitably disposed large riprap. The new piers consist of stone-filled timber cribs 20 feet wide, with grillage bottoms 28 feet wide, resting on a prepared foundation of small stone 20 feet below mean lake level, and surmounted by a concrete superstructure extending 6 feet above mean level.

Patrick Keohane, of Fayetteville, N. Y., was the lowest and best bidder for the work, and a contract was entered into with him on October 6, 1900. This contract provides for the construction of the west breakwater, 1,800 feet in length, entirely of stone; for two pierheads, 50 feet by 50 feet, spaced 500 feet apart at the entrance to the harbor, constructed of stone-filled timber cribs with concrete superstructure; for the construction or reconstruction of 1,615 feet of the east pier and 365 feet of the west pier in the manner already described, and for the dredging necessary to accomplish the removal of the old work and to prepare the foundations for the new work.

The estimated contract cost of the work described is $428,180.36.

In order to insure the integrity of the channel it was provided in the contract that the damaged portion of the east pier should first be rebuilt. This was to be followed in the order named by the construction of the other parts of the east and west piers, the pierheads at the entrance to the harbor, and the west breakwater, which is to follow shoreward from its pierhead.

Athough the contract provided that the work of framing cribs for the east pier should be commenced on or before April 1, 1901, the contractor simply made or attempted to make a technical compliance with this provision, and until very recently his efforts appear to have been devoted to opening up a quarry and securing materials. Within the past two weeks two cargoes of hemlock timber, aggregating about 650,000 feet B. M., and three carloads of bolts, have been received and unloaded at Lorain, and it is promised by the local representative of the contractor that the construction of the cribs for the east pier will be commenced at once and pushed to completion with energy during the present season.

Very respectfully,

G. T. Nelles,
U. S. Assistant Engineer.

Maj. Dan C. Kingman,
Corps of Engineers, U. S. A.

Q Q 8.

IMPROVEMENT OF CLEVELAND HARBOR, OHIO.

For a brief history of the early conditions and projects of improvement, see pages 2661 and 2662 of the Report of the Chief of Engineers, 1898, and pages 530 and 531 of Report of Chief of Engineers, 1899.

There are now two projects for improving the harbor of Cleveland, Ohio. The first is the project adopted under a provision of the river and harbor act of June 3, 1896, and provides for repairing and rebuilding the old works as a matter of maintenance, and is supplemented by the project previously adopted for completing the east breakwater.

This project and original estimate of cost cover the following items:

Renewing east pier 322 feet, renewing west pier 1,470 feet; total pier to be removed north of Lake Shore and Michigan Southern Railway bridge, 1,800 feet, at $100	$180,000
For pier south of Lake Shore and Michigan Southern Railway bridge, 260 feet, at $100	26,000
Dredging to deepen and widen channel above and below railroad bridge, 200,000 yards, at 20 cents	40,000
Contingencies of engineering, etc	14,000
Total for rebuilding piers and widening channel	260,000
Rebuilding superstructure of west breakwater with concrete, outside of opening in shore arm, and sheathing cribs with oak, 5,440 feet, at $100	544,000
Sheathing face of cribs of east breakwater, 2,764 feet, at $8.50	23,494
Contingencies of engineering, etc	32,506
Total for repairing breakwaters	600,000
For completing east breakwater under previous project	494,000
Total of estimate for repairs and construction	1,354,000

(See Reports of Chief of Engineers, 1895, page 410, and 1896, page 2952.)

The second project was adopted under the provisions of the river and harbor act of March 3, 1899. This project is for dredging the channel and the areas between breakwaters and harbor line to a depth of 21 feet. This dredging is all for the entire or partial restoration of previous depths of water, so that it is entirely a project for maintenance rather than for additional improvement. The estimated cost of dredging to a depth of 21 feet, as revised in June, 1899, was $235,300, while for dredging to a depth of 25 feet the estimated cost was $478,400. Dredging to the greater depth was recommended by the officer in charge of the improvement.

At the beginning of the fiscal year work was in progress for the renewal of the superstructure of the west breakwater, the extension of the east breakwater, the repair and renewal of the jetties, and for dredging in the channel and in the sheltered areas. All of this work was in progress under contracts previously made, and both the contracts and the work have been described in previous reports of the Chief of Engineers.

Under the contract with the Hunkin Brothers, of Cleveland, Ohio, dated April 27, 1897, the renewal of the superstructure of the west breakwater was continued. During the present fiscal year over 1,400 linear feet of the old superstructure was removed and nearly all of it replaced with concrete. The oak sheathing, fenders, and the strengthening of the substructure have kept pace with the concrete work.

Under the contract with the L. P. J. A. Smith Company, of Cleveland, Ohio, the jetties have been repaired and capped with concrete. About 575 linear feet of new superstructure was made during the present year, 1,431 feet of the old fender and old pier were removed, and 1,311 feet of channel dredged. The work of extending the east breakwater was continued and 1,120 linear feet of cribs sunk in place for the substructure, and the superstructure has been completed over about one-half this distance. Dredging in the harbor and sheltered areas was continued until the exhaustion of the funds available for the purpose. About 40,000 cubic yards of material was removed during the present year.

The work of cement testing was continued throughout the year, and the results are embodied in the report of Assistant Engineer G. T. Nelles, to which attention is respectfully invited.

I think it important to invite attention to the necessity of securing a greater depth in the harbor of Cleveland than that afforded by the 21-foot depth now proposed, which is measured down from mean lake level. The mean lake level was determined many years ago and is an arbitrary plane hardly reached at all by the highest water during the past year. It would seem more logical to refer all depths to mean low water and to avoid the necessity of minus gauge readings. Gauge observations at Cleveland for the past year show that there was not a single month during the year in which the mean level of the water surface was as high as the datum, known as mean lake level. The minimum level for any one month was 2.7 feet below the datum and the mean for the entire year 1.2 feet below it.

The city of Cleveland has done a large amount of work in the improvement and maintenance of the channels within the old shore line of the lake. It is stated that in the neighborhood of $200,000 was expended by the city in these improvements during the past twelve months, and more than 200,000 cubic yards of material has been dredged in making them.

The United States has exercised no supervision over these works except as to dumping of dredged material. A dumping ground has been established some 2 or 3 miles out in the lake, and the distance to it is so great that the dumping can not be conveniently supervised from the shore. The whole lake is so shallow that dumping must be done with care to prevent the material from becoming an obstruction to navigation. To enable this work to be properly supervised, as well as to facilitate the inspection of the work of improvement of the harbor, authority has recently been granted to purchase a suitable steam or naphtha launch at a cost not to exceed $1,400.

The emergency river and harbor act of June 6, 1900, provided for a preliminary examination and survey of Cleveland Harbor, Ohio, "with a view to the further improvement of said harbor: First, by such additional construction or extension as may be found necessary to provide a safer and better entrance for vessels at the main entrance to the breakwater of said harbor; second, to provide such additional harbor room as may be found necessary by an extension eastward of the breakwater now under construction in said harbor."

The freight tonnage of Cleveland Harbor is very large. It amounted to more than 7,500,000 tons in the year 1900, an increase over the previous year of 178,000 tons. Large as is the commerce, this increase is considerably less than that in many of the other harbors in the district, and this would seem to indicate that the present business is now very nearly equal to the maximum capacity of the harbor.

The harbor room within the river mouth is very much cramped, and the approaches to it by land are difficult and are through the heart of the city. An extension of the breakwater eastward, whereby sufficient docks might be constructed along the lake shore, would seem to be the only relief from this condition.

Cleveland Harbor is in the collection district of Cuyahoga, Ohio. There are four lights to mark the entrance between breakwaters and piers and a fog signal on pier in rear of east end of west breakwater.

During the squall on June 27, 1900, the barge *John Fritz*, of Duluth, belonging to the Bessemer Steamship Company, drifted against the outer end of the partially completed west pier in the harbor of Cleveland, Ohio, and injured it to such an extent that it was necessary to rebuild a section of the superstructure 30 feet long. It was understood at the time of the accident that the owners of the vessel would repair the damage done, but after considerable delay the contractors for the removal of the superstructure of the west pier undertook the work under Government supervision, and on completion presented a bill amounting to $2,315.67. The payment of this account was finally authorized by the proper authority, and it was paid by the United States. It is understood that a claim for this amount against the steamship company is now in the hands of the Department of Justice for collection.

In the night of June 11, 1901, the steamer *Superior*, owned and operated by the Euclid Beach Park Company, of Cleveland, Ohio, collided with the east pier in the harbor of Cleveland, Ohio, and broke one of the oak fenders and otherwise damaged the pier to an amount estimated at $90.

A report of this injury was made to the United States attorney for the northern district of Ohio, and a further report from this office has been made to the effect that this injury was not maliciously made, and that a payment of $90 to repair the injury would probably meet the ends of justice. The injury has not yet been repaired.

Money statements.

PROJECT UNDER CONTINUOUS CONTRACT.

July 1, 1900, balance unexpended	$515,463.93
June 30, 1901, amount expended during fiscal year	236,386.73
July 1, 1901, balance unexpended	279,077.20
July 1, 1901, outstanding liabilities	22,271.96
July 1, 1901, balance available	256,805.24
July 1, 1901, amount covered by uncompleted contracts	296,068.51
Amount (estimated) required for completion of existing project	353,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	100,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

DREDGING TO A DEPTH OF 21 FEET.

July 1, 1900, balance unexpended		$17,888.88
June 30, 1901, amount expended during fiscal year		17,888.88
Amount (estimated) required for completion of existing project		160,300.00
Amount that can be profitably expended in fiscal year ending June 30, 1903:		
For works of improvement	$160,300.00	
For maintenance of improvement	14,700.00	
		175,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

Amount and date of all appropriations for improving the harbor of Cleveland, Ohio.

March 3, 1825	$5,000.00	March 3, 1875	$50,000.00
March 2, 1827	10,000.00	August 14, 1876	50,000.00
March 3, 1829	12,179.00	August 14, 1876 (repair of pier)	8,000.00
April 23, 1830	1,786.56	June 18, 1878	100,000.00
March 2, 1831	3,670.00	March 3, 1879	100,000.00
July 3, 1832	6,600.00	June 14, 1880	125,000.00
June 28, 1834	13,315.00	March 3, 1881	200,000.00
July 2, 1836	15,006.59	August 2, 1882	175,000.00
March 3, 1837	10,000.00	July 3, 1884	100,000.00
July 7, 1838	51,836.00	August 5, 1886	93,750.00
June 11, 1844	25,000.00	August 11, 1888	100,000.00
August 30, 1852	30,000.00	September 19, 1890	75,000.00
March 3, 1853	145.69	July 13, 1892	100,000.00
June 28, 1864 (allotment)	20,000.00	August 18, 1894	50,000.00
June 23, 1866	59,806.00	June 3, 1896	80,000.00
June 25, 1868 (allotment)	17,000.00	June 4, 1897	350,000.00
April 10, 1869 (allotment)	13,380.00	July 1, 1898	294,000.00
July 11, 1870	20,000.00	March 3, 1899	75,000.00
March 3, 1871 (allotment for repairs)	636.77	March 3, 1899	100,000.00
March 3, 1873	1,000.00	June 6, 1900	175,000.00
June 24, 1874	30,500.00		
Total previous to adoption of project for harbor of refuge	346,881.61	Total	2,747,631.61
		Expended to June 30, 1901	2,468,554.41
		Unexpended July 1, 1901	279,077.20

NOTE.—Appropriation of March 3, 1899, was for dredging in the anchorage and channel between piers. This sum has been expended. Balance of appropriations available for project under continuous contracts, $279,077.20.

NOTE.—Since the adoption of project for outer harbor about $120,000 has been expended for maintenance of channel, piers, and breakwater.

LIST OF CONTRACTS FOR IMPROVING HARBOR AT CLEVELAND, OHIO, IN FORCE DURING THE FISCAL YEAR ENDING JUNE 30, 1901.

Contract for repair of west breakwater.

Name of contractor: Hunkin Brothers, Cleveland, Ohio.
Date of contract: April 28, 1897.
Date of approval: May 19, 1897.
Date of commencement: August 3, 1897.
Date of completion: Continuous contract.

Contract for construction of east pier, removing part of old west pier, dredging, and completing east breakwater.

Name of contractor: The L. P. & J. A. Smith Company, Cleveland, Ohio.
Date of contract: July 16, 1898.
Date of approval: August 11, 1898.
Date of commencement: August 15, 1898.
Date of completion: Continuous contract.

Contract for dredging.

Name of contractor: W. A. McGillis & Co., Cleveland, Ohio.
Date of contract: June 12, 1899.
Date of approval: July 7, 1899.
Date of commencement: July 10, 1899.
Date of completion: August 31, 1900.

COMMERCIAL STATISTICS.

The following statistics for the year 1900, relative to the commerce of the harbor of Cleveland, Ohio, were compiled from a statement published by the collector of customs in the Cleveland Leader January 1, 1901:

Receipts.	Tons.	Shipments.	Tons.
Iron ore	3,823,314	Coal (bituminous)	1,936,623
Lumber, logs, etc	869,536	Coal (anthracite)	256,908
Stone	163,033	Iron and steel	27,967
Pig iron	10,256	Grain and produce	100,997
Grain and produce	28,522	Nails	20,098
Asphalt	2,449	Miscellaneous	206,243
Trap rock	12,775		
Gravel	7,289		
Miscellaneous	108,423		
Total	5,020,597	Total	2,548,826

Total freight tonnage:	
1900	7,569,423
1899	7,390,921
Increase	178,502

Vessels.	Number.	Tonnage.
Entering	3,877	3,568,530
Departing	3,615	3,496,254
Built	7	14,128

Total registered tonnage (vessels entering and departing):	
1900	7,064,784
1899	7,295,002
Decrease	230,218

Draft of largest vessels using harbor, 19 feet. Largest vessels do not load to full depth. No new vessel lines established during the year.

REPORT OF MR. G. T. NELLES, ASSISTANT ENGINEER.

CLEVELAND, OHIO, *June 30, 1901.*

MAJOR: I have the honor to submit the following report of operations at Cleveland Harbor, Ohio, for the fiscal year ending June 30, 1901:

Under your orders of June 7, 1901, I assumed local charge of the works of improvement in Cleveland Harbor. Consequently my connection with the works has been so brief that I have been obliged to rely upon the records of the office and information gathered from inspectors and others familiar with the harbor in preparation of this report.

The work of the year has been carried on under three contracts, as follows:

1. With Hunkin Brothers, of Cleveland, dated April 28, 1897, for repairing west breakwater.
2. With The L. P. & J. A. Smith Company, of Cleveland, dated July 2, 1898, for constructing part of west pier, dredging channel, and completing east breakwater.
3. With W. A. McGillis & Co., of Cleveland, dated June 21, 1899, for dredging in harbor.

WEST BREAKWATER REPAIRS.

The part of the west breakwater to be repaired includes the entire lake arm, a spur 100 feet long near the harbor entrance, and all of the shore arm outside of the opening at the west end of the harbor. It consists of 108 stone-filled timber cribs, each 50 feet long; the 5 cribs next to the opening at the west end are 28 feet wide, the next 5 cribs are 30 feet wide, and the remaining 98 cribs, including 2 cribs in the spur, are 32 feet wide. Originally these cribs were all surmounted by a continuous stone-filled timber superstructure 8 feet above mean level, of same width as cribs, and also for 3,530 feet by a timber parapet on the lake side 4 feet high and 16 feet wide.

The work to be done under the contract with Hunkin Brothers comprised the removal of the old superstructure to a depth of 3 feet below the mean level and replacing it with a concrete superstructure composed of concrete blocks 4 feet wide, 3.5 and 4 feet high, and about 10 feet long, placed longitudinally along the outer and middle walls of the cribs; the space between these blocks is leveled off and planked over at mean lake level and the whole covered to a height of 5 feet with mass concrete in blocks 30 feet wide, alternating 20 and 30 feet in length; a concrete parapet 5 feet high, 10 feet wide on top, and 13 feet wide on base is finally placed on the lake side of the structure. A single oak fender was originally provided on the harbor side, 3 feet below mean level, and the lake side of the old cribs is to be suitably protected by means of 4-inch oak sheathing. By supplementary agreements, provision is made for the addition of a double oak fender along the harbor side above the water surface, for changing the depth to which the old superstructure shall be removed to an average of 2.5 feet on the side walls, and for repairing breach caused by whaleback barge in November, 1898, and for leveling and reenforcing the old cribs.

The total estimated cost of this contract, as given in voucher No. 22, December, 1900, accounts of Col. S. M. Mansfield, is $434,375.52; the value of the work completed to June 30, 1901, is approximately $299,149.31, leaving work to the amount of $135,226.21, or about 31 per cent of the whole contract, yet to be done.

The operations of the present fiscal year were practically discontinued between November 1, 1900, and May 1, 1901, on account of stormy and inclement weather, making the working season six months. The work completed during the fiscal year and the total amount of work completed to the end of the year are shown by the following table. The figures for the fiscal year are slightly in excess of the actual work done because it has heretofore been the custom to estimate the lengths by calling the old cribs 50 feet each and making no allowance for surplus, whereas in the present case the actual measured length to the end of the year's work has been obtained, so that the difference between the totals for this year and last include all the surplus.

Designation.	Completed during fiscal year 1901.	Total completed to June 30, 1901.
	Linear feet.	*Linear feet.*
Old superstructure removed	1,413.23	3,903.23
Concrete base completed	1,383.23	3,873.23
Concrete parapet completed	1,433.23	3,823.33
Oak sheathing on lake side	1,004.5	3,236.30
Oak fender on harbor side	1,134	3,204
Concrete blocks made	401	1,227
Concrete blocks placed	418	1,169

The kind and quantities of the various materials entering into the construction of the work for which payment is made under the contract is as follows:

Materials used.		During fiscal year 1901.	Total to June 30, 1901.
White-oak sheathing and fenders	feet B. M.	112,971.8	297,479.1
Hemlock floor under base	do	68,734	193,105.5
Old timbers in cross walls, etc	do	133,566	344,839.3
Concrete blocks in superstructure	cubic feet	64,326.2	180,231.7
Concrete blocks in steps	do	124	124
Mass concrete in superstructure	cubic yards	10,483.73	29,279.64
Bolts, rods, spikes, etc	pounds	57,975.9	157,807.1
Stone filling, between cribs	cubic yards	106	179

The estimated value of the actual work done during the year on The west breakwater repairs is $108,168.92.

WEST PIER AND CHANNEL.

The part of the west pier constructed under contract with The L. P. & J. A. Smith Company covers a length of 1,440 feet, commencing at a point 91 feet north of the center line of the Lake Shore and Michigan Southern Railway bridge, and extending in a northwesterly direction parallel to and 325 feet from the pier on east side of channel. The pier consists of stone-filled timber cribs resting on a foundation of small stone, 23 feet below mean lake level. These cribs are all 288 feet in length and 20 feet in width, with a grillage bottom 25 feet wide. The superstructure consists of line concrete blocks 3.5 feet high, 4 feet wide, and about 9 feet long, resting on outside walls of the cribs 2.5 feet below mean level—the space between the blocks is leveled up and floored over at mean level, and the whole covered over with mass cement in blocks 19.6 feet wide and 27 feet long, with top surface 4.5 feet above mean level. A continuous fender of oak piles and waling pieces protects the channel face and end of the pier. The plans contemplate the extension of the pier and channel southward to the Lake Shore and Michigan Southern Railway bridge, but owing to legal complication concerning the right of way it has not been possible to carry them out. Work on the concrete superstructure of this pier was in progress at the beginning of the year, and, with the pile fender, was completed in September, 1900. After completing the west pier the removal of the old west pier and dredging the channel between the piers to a depth of at least 20 feet at mean stage was taken up by the contractor and finished during the fall of 1900.

The total work completed at the west pier and in the channel for and to the end of the present fiscal year is shown below:

Designation.	Completed during fiscal year 1901.	Total completed to June 30, 1901.
	Linear feet.	*Linear feet.*
Timber-crib superstructure	....	1,440
Concrete superstructure	574.9	1,406.21
Pile fender	....	1,433
Old pier removed	1,431	1,431
Channel dredged	1,311	1,311

The materials and quantities entering into this work are given in the table showing the totals for the Smith contract, under head of "East Breakwater Extension."

EAST BREAKWATER EXTENSION.

The work covered by this part of The L. P. & J. A. Smith Company's contract comprises the construction of almost 3,000 feet of stone-filled timber-crib breakwater, beginning 2,495 feet east of the entrance to the harbor and extending on the same alignment 1,005 feet, thence at an angle of 64 degrees toward the shore for about 2,000 feet. The structure consists of stone-filled timber cribs 32 feet wide, with grillage bottoms 34 feet wide, resting on a stone foundation 26 feet below mean lake level prepared under an independent contract in 1899. All of the cribs are 216 feet long, except the special one at the angle, which is 140 feet long. The superstructure is also built up of timber and filled with stone for a width of 12 feet and height of 8 feet above mean lake level on the harbor side, sloping thence down to 1 foot above mean lake level on the lake side. The decking consists of 12 by 12 inch timbers protected by straps at the angle on the lake side. The object of this form of breakwater was to allow the seas to break over it and to thus prevent them from chasing along the structure to the harbor entrance. From information furnished me by those who have had an opportunity to observe the effect of the breakwater during storms, it appears certain that this desirable result will be accomplished.

The operations for the present year commenced with the construction of crib No. 5. This crib is the last one in the lake arm of the breakwater; it is 140 feet long and specially constructed at the end so as to form the angle toward the shore. Six cribs were completed and placed during the year as follows:

Crib—	Completed.	Sunk in place.
No. 5	July 18, 1900	Aug. 11
No. 6	Aug. 16, 1900	Aug. 23
No. 7	Sept. 20, 1900	Oct. 9
No. 8	Nov. 7, 1900	May 9
No. 9	May 2, 1900	May 30
No. 10	June 24, 1900	June 27

The superstructure of cribs 5, 6, and 7, and the heavy riprap protection along both sides of these cribs was finished in December, 1900. The work actually completed on the east breakwater during and to the end of the fiscal year is as follows:

Designation.	Completed during fiscal year, 1901.	Total completed to June 30, 1901.
	Linear feet.	*Linear feet.*
Crib substructure complete in place	1,120	2,084
Superstructure complete	572	1,436
Sheathing lake side old breakwater	84	84

The following tabulation shows the total quantities and kind of materials used by the Smith Company in the construction of west pier, the removal of the old west pier, dredging channel, and extending east breakwater, for the year and since the beginning of the work:

Designation.		During fiscal year 1901.	Total to June 30, 1901.
Hemlock timber	feet B. M.	2,205,016	6,106,956
White-pine timber	do	396,483	1,456,516
Oak timber	do	205,633	399,168
Piles (oak)	linear feet	6,680	11,368
Rods, straps, bolts, etc	pounds	734,463	1,887,017
Riprap stone	tons	39,882	176,743
Sand filling	cubic yards	....	7,276
Concrete blocks	cubic feet	....	38,402
Concrete (mass)	cubic yards	2,003	4,695
Removing old pier	linear feet	1,431	1,431
Dredging	cubic yards	136,547	277,738

The estimated value of the work done during the fiscal year is $121,976.59. The total estimated cost of this contract according to voucher 24, November, 1900, accounts of Col. Jared A. Smith, and including the actual cost of repairs made under the contract, is $450,756.21. The value of the work actually accomplished to June 30, 1901, is $316,829.23, which leaves work to the value of $133,926.98, or 29 per cent of the whole contract, yet to be done.

DREDGING IN HARBOR.

This work comprised the dredging of the harbor and channel to a depth of 21 feet at mean level from Seneca street to 300 feet west of the west pier. The contract was completed August 6, 1900, the work done having been distributed as follows:

		During fiscal year 1901.	Total to June 30, 1901.
Dredging in east basin	cubic yards	2,062	525,893
Dredging in west basin	do	39,897	39,897
Dredging in channel	do	8,309	8,309
Total	do	40,268	584,099

An examination of the most recent maps and soundings shows that a depth of fully 20 feet is available over the area described above, and dredged under the McGillis contract.

CEMENT TESTS AND OBSERVATIONS.

In connection with the completion of west pier and the repairs of the west breakwater, it has been necessary to carry on extensive tests to determine the quality of the cement used, under the following general specifications:

"The cement must be a high-grade American Portland of uniform quality and must fulfill the following requirements. Briquettes of neat cement allowed to harden for twenty-four hours in moist air and kept for the balance of time in water must at the end of seven days show a tensile strength of not less than 450 pounds per square inch, and at the end of twenty-eight days not less than 575 pounds per square inch. Briquettes of one part cement and three parts sand, treated in the same manner as above, must at the end of seven days show a tensile strength of not less than 150 pounds per square inch and at the end of twenty-eight days not less than 225 pounds per square inch. Briquettes either neat or with sand when kept for longer periods must have a tensile strength at least as the requirements for twenty-eight days."

"The initial set of the cement as determined by a wire one-twelfth inch in diameter loaded to weigh one-fourth pound must not take place in less than forty-five minutes." The Medusa brand of American Portland cement, manufactured at Sandusky, Ohio, has been used exclusively in all work herein described. The cement has been delivered at the contractor's warehouse in cloth sacks weighing 95 pounds each. Each consignment is sampled by taking a small quantity from each tenth sack. These samples are combined in lots of five to represent 50 sacks. Originally in addition to the pat tests and test for fineness, 15 briquettes of neat cement are made, 5 to be broken in seven days, 5 in twenty-eight days, and 5 in six months. Occasionally extra briquettes are made for longer time tests. Since the completion of west pier, no sand briquettes have been made, as the west breakwater specifications do not require it.

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All the cement used has been mixed very dry by machinery in the following proportions. For blocks: One part cement, two parts sand, two parts gravel, three parts stone. For mass concrete: One part cement, three parts sand, three parts gravel, four parts stone. Using 5 cubic feet of cement (475 pounds) the block formula produces 1 cubic yard and the mass formula 1.25 cubic yards concrete in place, or about 67½ per cent of the total volume of the constituent parts.

INJURIES AND REPAIRS TO EXISTING WORKS.

During a squall on July 7, 1900, the barge *John Fritz*, of Duluth, drifted against the outer end of the partially completed west pier and injured it to such an extent that it was necessary to rebuild a section of the superstructure 30 feet long. It was understood at the time of the accident that the owners of the boat would repair the damage done, but after considerable delay the contractors for the west pier construction undertook the work under Government supervision, but without special orders, and on completion presented a bill amounting to $2,315.67. The payment of this account was eventually authorized by the proper authorities and a claim for the amount against the steamship company placed in the hands of the United States district attorney for collection.

The superstructure of crib No. 3, east breakwater extension, was injured in November, 1900, by an unknown vessel and repaired at a cost of $18.41.

The substructure of crib No. 9 was similarly injured in May, 1901, and will be repaired when the superstructure is added.

In December, 1900, the entire parapet of the old portion of the east breakwater was repaired and put in condition to withstand the winter storms, at a cost of $463.85.

On June 11, 1901, the steamer *Superior* collided with the east pier, and in addition to other injuries completely demolished one of the oak fenders, doing an estimated damage of $90.

The excellent mooring facilities along the east breakwater resulted in a very general use of the structure for this purpose, and so much damage of a minor nature was caused in this way that it finally became necessary to prohibit vessels from lying alongside the breakwater except in case of emergency.

DUMPING GROUND.

The present city dumping ground is located near temporary waterworks crib No. 1, nearly 2 miles out into the lake.

In November, 1898, the area within which materials may be deposited under proper restriction in Cleveland Harbor was defined by order of the Chief of Engineers on Lake Erie Coast Chart No. 5 as follows: The area bounded by east and west and by north and south lines through temporary waterworks cribs Nos. 1 and 2 situated 11,600 and 18,800 feet, respectively, from the shore end of the new waterworks tunnel. The area thus designated is approximately 1.5 miles long east and west by 0.5 mile north and south and contains between 400 and 500 acres, over which a depth of about 45 feet was found to exist.

Since the establishment of these grounds suitable buoys have been placed from time to time and the necessary instructions issued to tug captains and others making use of them. A least depth of 35 feet has been fixed as the safe limit, and when this is reached the buoys are changed. The last inspection of the grounds was made on May 4, 1901, by Mr. William T. Blunt, United States assistant engineer. Concerning this inspection Mr. Blunt reported as follows on May 20: "The buoy was found to be practically in the same position as placed on July 29, 1900, and reported on under date of August 8, 1900. The present inspection shows that dumping is still continued southwest of the buoy, although tugs have been ordered to go around the buoy, and to dump northeast of it. This action has been provided for by moving the buoy to the extreme northeast corner of the ground as stated in my letter of August 8, 1900. The least depth found was about 35 feet at mean level, about 400 feet southwest of the buoy. As this depth very nearly approaches the limit of safety, it will be necessary to move the buoy to a new position very soon."

Numerous complaints of illegal dumping in the harbor and channel have been made during the year, and efforts to locate the offending parties have resulted in the filing of two complaints under the provision of the river and harbor act of 1899.

The equipment of the harbor is entirely inadequate for the proper supervision and inspection of the works and the enforcement of the existing rules and regulations for the protection of the harbor, and the purchase of a steam or gasoline launch for the purpose has been recommended.

The old dumping ground off Case avenue was last examined in October, 1900, by Mr. Blunt. A least depth of 21 feet at mean level was found. In his report Mr. Blunt states that the bottom appears to have been leveled off materially by the action of the waves, and that the least depth had increased from 17.5 to 21 feet between September, 1898, and October, 1900. The normal depth at this locality is about 38 feet.

LAKE LEVELS.

The highest, lowest, and mean elevations of the water surface at Cleveland gange for each month in the year, with reference to the mean lake level for 1860 to 1875, are given in the following table.

	Highest elevation.	Lowest elevation.	Mean elevation.
1900.			
July	−0.08	−0.84	−0.43
August	−0.27	−0.71	−0.46
September	−0.08	−1.46	−0.78
October	−0.46	−1.48	−1.02
November	−0.01	−2.40	−1.28
December	−0.89	−2.22	−1.82
1901.			
January	−0.28	−1.99	−1.42
February	−0.88	−2.22	−1.77
March	−1.30	−2.70	−1.89
April	−1.68	−1.81	−1.48
May	−0.94	−1.97	−1.46
June	−0.65	−1.56	−1.06
For fiscal year 1901	−0.01	−2.70	−1.20

NOTE.—The plane of reference of the Cleveland gauge is 2.84 feet above mean level of the lake from 1860 to 1875.

WORK DONE BY THE CITY OF CLEVELAND.

The city of Cleveland, through its department of harbors and docks, has assumed the improvement and maintenance of the channel in the Cuyahoga and Old rivers south of the Lake Shore and Michigan Southern Railway bridge at the lake shore, and also have under construction extensive docks and wharves along the lake front, between Erie and Seneca streets. During the past twelve months in the neighborhood of $200,000 has been expended by the city in these improvements.

Through the courtesy of Mr. J. W. Sturdevant, assistant engineer in charge of the department, I have been furnished with the advance sheets of his annual report, from which I have extracted the following information:

The city aims to maintain a navigable channel in which the depth is at least 20 feet at mean lake level in the Old River and in the Cuyahoga River between the lake and the New York, Pennsylvania and Ohio Railway bridge, 4 miles above the lake; between this bridge and Jefferson street, a distance of about one-fourth mile, a depth of 16 feet is obtained; between Jefferson street and the so-called weigh lock of the

Ohio Canal, a distance of one-half mile, the depth is twelve feet. To accomplish this, during the past twelve months it has been necessary to take a single dredge cut for practically the whole distance mentioned, in addition to the removal of extensive local deposits at the mouths of the various tributary streams and sewers, involving the dredging of over 200,000 cubic yards of material.

At Collision Bend, between lower and middle Seneca street bridges, a locality which takes its name from the number of accidents occurring there on account of the narrow channel and sharp curvature, the river has been widened and improved at a cost of nearly $100,000, so as to offer increased dockage facilities and at the same time provide a safer and better channel for the passage of vessels.

Between Sycamore and West River streets the widening of the river to 350 feet is in progress, and new docks are being constructed at street intersections and other public property.

The lake-front improvement between Erie and Seneca streets has progressed steadily, and at this time the main dock, which incloses nearly 60 acres, has been nearly completed, and work has been commenced on the wharfs at the northeast corner, forming the first slip. The whole area inside of the main dock is to be filled up; this filling is being done by utilizing the space as a dump for city refuse and some dredged materials from the river and adjacent docks.

CONCLUSION

The construction work done by the United States in Cleveland Harbor during the year has been under the direct supervision of Mr. L. C. Schnell, principal inspector, assisted by P. Hourihan on the east breakwater, Francis D. Davis on the crib construction, John E. Brooks, Frank C. Burgess, and John H. Sutherland on the west breakwater repairs. I have had frequent occasion since assuming local charge of the work to examine and inspect it critically, and have found its condition such as to indicate an efficient and thorough inspection and supervision.

Very respectfully, your obedient servant,

G. T. Nelles,
U. S. Assistant Engineer.

Maj. Dan C. Kingman,
Corps of Engineers, U. S. A.

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IMPROVEMENT OF FAIRPORT HARBOR, OHIO.

For an explanation of location, projects of improvement, and the general conditions at this harbor, see pages 2676 and 2677, Report of the Chief of Engineers, 1898.

The present project is for the construction of two breakwaters converging toward the lake, with a space of about 500 feet between outer ends, to form an entrance.

The primary object of the arrangement of the breakwaters is to prevent the formation of sand bars at the entrance, which has heretofore been the cause of very great and frequent obstructions to navigation, as well as of much expense for maintenance of channels. Should the bar re-form within the sheltered area the expense of its removal will be far less than heretofore, because the dredge while doing the work will be sheltered by the breakwater from the effect of the waves.

The appropriation of 1896 for this harbor was not considered sufficient to justify the commencement of construction of the breakwater, and it was accordingly held until more funds were available, only such portion being used as was necessary for maintaining the channel by dredging. The appropriation of March 3, 1899, furnished, with the balance on hand, a sufficient sum of money to undertake the work.

Accordingly, a contract was entered into June 26, 1899, with James B. Donnelly, of Buffalo, N. Y., for the construction of a part of the west breakwater in accordance with the project of March 31, 1896.

Under this contract 828 linear feet of the inner end of the west breakwater has been built. This structure rests upon a prepared foundation of small stone deposited in a dredged trench. It consists of timber cribs filled with stone and surmounted by a continuous timber superstructure. It is protected from scour by wide mattresses and heavy riprap. The cribs were constructed at the contractor's yards in Buffalo, N. Y., and towed to Fairport. The contract was finally closed November 15, 1900, an extension of time having been necessary to permit the contractor to complete the work. The cost of this section of breakwater amounted to nearly $125 per linear foot.

The total length of the proposed west breakwater will be 2,050 feet and the east breakwater 1,350 feet. It is proposed to change the style of construction and to adopt a breakwater constructed entirely of stone, in accordance with the approved section, and to use timber cribs only for the pier heads and to cap them above water with concrete.

Under authority of the Chief of Engineers the estimate for the completion of this work was increased from $480,000 to $510,000 in the Report of Chief of Engineers for 1900.

Great trouble is experienced in maintaining the required depth at this harbor. Extensive dredging has been necessary for a number of years. The shore line to the westward of the jetties is advancing rapidly and is now about 1,700 feet out from where it was when the improvement was commenced. It may be necessary before long to consider the expediency of constructing one or more groins to the westward of the harbor in order to arrest the movement of sand.

On July 31, 1900, it was necessary to make an allotment of $3,000 from the appropriation for "Emergencies in River and Harbor Works," act of June 6, 1900, to dredge through the bar which had formed outside the jettied channel. This work was done under contract between September 15 and October 11, 1900, about 13,500 cubic yards of material being removed. In the spring of 1901 the bar had again reformed, giving a depth over it of not more than 14 feet. This being insufficient for the needs of navigation, the United States dredging plant was sent to the harbor in April, and during April and May removed about 30,000 cubic yards of sand and restored the depth to 21 feet.

The old jetties being in very bad condition an examination of them has recently been made and authority has been granted to make temporary repairs to the outer end of the east jetty, and also to the decking of both jetties, and to cover exposed places by a sheathing of oak plank. The total cost of these repairs will be about $5,550, and the work is to be done by hired labor.

The cost of maintenance of harbor at Fairport must very soon include extensive repairs and rebuilding of a large portion of the old jetties of wooden cribs filled with stone. A length of 617 feet on the west side and 520 feet on the east side is now in fair condition, having been built in sections from 1883 to 1893. These parts are in need of repairs, which, if soon made, will add very much to the time which they will last. To sheathe the exposed faces and to repair the superstructures is now estimated to cost $25 per foot of pier.

On the east side all of the jetty south of the outer end of the ore wharf is in possession of the dock companies. A length of 595 feet is in very poor condition, and while it may last a very few years, it is not prudent to defer the repair until the superstructure falls into the channel. It should therefore be rebuilt within a very few years.

On the west side, between life-saving station and section built in 1896, a length of about 625 feet should be rebuilt as soon as may be practicable.

South of life-saving station a length of 1,075 feet, all well inside of shore line, is in very bad condition, but as long as it will serve as a revetment to prevent sliding in of the bank it will be useful. At the end of a few years, however, it will probably be found necessary to add some further work to protect the bank.

The cost of such work as is now or is soon to be needed is estimated as follows:

Sheathing and repairing 617 linear feet of pier on west side and 520 feet on east side, a total of 1,137 feet, at $25 per foot	$28,425.00
Rebuilding 625 feet of pier on west side and 595 feet on east side, 1,220 feet, at $120 per foot	146,400.00
Maintenance of channel one year by dredging	10,000.00
Total	184,825.00

A portion of this amount is absolutely necessary to maintain the harbor, and all of it could be advantageously expended in one year.

The commerce of Fairport during the year 1900 amounted to 1,688,147 tons, received and shipped. This is a trifle less than the amount handled during the previous year, but the tonnage of vessels entering the harbor shows an increase of nearly 1,000,000 tons. This was due to the large iron ore vessels coming to the harbor and not having sufficient material to load when they went away.

For a more detailed description of the work done during the present fiscal year attention is respectfully invited to report of Assistant Engineer G. T. Nelles, which is transmitted herewith.

Fairport Harbor is in the collection district of Cuyahoga, Ohio. There is a fixed white light of the fourth order on the bluff, and a range of two beacons on the east pier.

In September, 1900, the steamer *Spokane* attempted to enter the harbor at Fairport, Ohio, and in so doing struck against the outer end of the east jetty, doing it considerable damage.

An examination has recently been made, and it was ascertained that the cost of repairing and sustaining this jetty head will amount to $1,825. No attempt appears to have been made by the officer then in charge of the district to collect the damage from the owners of the steamer *Spokane*, and I am of the opinion that no effort ought to be made.

The jetties at Fairport are very close together, and it is extremely difficult for a vessel to enter them at any time when the wind is blowing. During a storm a vessel would better take its chances in the open lake than attempt to gain the shelter of Fairport Harbor. If a vessel tries to come in it stands great danger of striking the jetty heads. I do not think that the owners ought to be held responsible if they do.

The entrance is not yet sheltered by the construction of a proposed breakwater, and in any case I think the jetty heads ought to be made strong enough not to be injured by an accidental collision.

Money statement.

July 1, 1900, balance unexpended		$119,473.61
Allotment, emergency river and harbor act, June 6, 1900		3,000.00
		122,473.61
June 30, 1901, amount expended during fiscal year		110,919.33
July 1, 1901, balance unexpended		11,554.28
July 1, 1901, outstanding liabilities		9.90
July 1, 1901, balance available		11,544.38
Amount (estimated) required for completion of existing project		480,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901:		
For works of improvement	$200,000.00	
For maintenance of improvement	184,825.00	
		384,825.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

Amount and date of all appropriations for improving harbor at Fairport, Ohio.

March 3, 1825	$1,000.00
May 20, 1826	5,620.00
May 19, 1828	9,135.11
April 23, 1830	5,563.18
March 2, 1831	5,680.00
July 3, 1832	2,600.00
June 28, 1834	10,000.00
July 2, 1836	6,000.00
July 7, 1838	10,000.00
June 11, 1844	10,000.00
August 13, 1852	10,000.00
June 28, 1864	24,435.24
June 23, 1866	24,072.00
March 2, 1867	60,000.00
June 23, 1874	20,000.00
March 3, 1875	15,000.00
August 14, 1876	5,000.00
June 18, 1878	5,000.00
June 14, 1880	$3,000.00
March 3, 1881	10,000.00
August 2, 1882	10,000.00
July 5, 1884	10,000.00
August 5, 1886	18,750.00
August 11, 1888	10,000.00
September 19, 1890	20,000.00
July 13, 1892	35,000.00
August 18, 1894	20,000.00
June 3, 1896	30,000.00
March 3, 1899	100,000.00
June 6, 1900 (allotment)	3,000.00
Total	498,873.53
Expended June 30, 1901	487,319.25
Unexpended July 1, 1901	11,554.28

CONTRACT FOR CONSTRUCTING A PART OF WEST BREAKWATER IMPROVING HARBOR AT FAIRPORT, OHIO, IN FORCE DURING THE FISCAL YEAR ENDING JUNE 30, 1901.

Name of contractor: James B. Donnelly, Buffalo, N. Y.
Date of contract: June 26, 1899.
Date of approval: August 4, 1899.
Date of commencement: May 1, 1900.
Date of completion: November 15, 1900.

COMMERCIAL STATISTICS.

The following statistics for the year 1900 relative to the commerce of the harbor of Fairport, Ohio, were compiled from information furnished by the collector of customs and others:

Receipts.	Tons.	Shipments.	Tons.
Iron ore	1,085,554	Coal	253,593
Grain	133,399	Miscellaneous	50,861
Stone	29,525		
Miscellaneous	135,215		
Total	1,383,693	Total	304,454

Total freight tonnage:	
1900	1,688,147
1899	1,720,283
Decrease	32,136

Vessels.	Number.	Tonnage.
Entering	775	1,051,160
Departing	769	1,044,845

Total registered tonnage:	
1900	2,096,005
1899	1,101,336
Increase	994,669

Draft of largest vessels using harbor, 20 feet. Largest vessels do not load to full depth. No new vessel lines established during the year.

REPORT OF MR. G. T. NELLES, ASSISTANT ENGINEER.

CLEVELAND, OHIO, *June 30, 1901.*

MAJOR: I have the honor to submit the following report of operations at Fairport Harbor, Ohio, for the fiscal year ending June 30, 1901:

A contract was entered into on June 26, 1900, with James B. Donnelly, of Buffalo, N. Y., for the construction of a part of the west breakwater, in accordance with the project of March 31, 1896. Under this contract the inner 828 feet of breakwater, consisting of three stone-filled timber cribs 216 feet long and one crib 180 feet long, were completed during the fall and winter of 1900. These cribs were 26 feet wide, with a projecting grillage bottom 38 feet in width, resting on a foundation of small riprap stone 2 feet thick 24 feet below mean lake level; they extend 5 feet above mean lake level on the harbor side and 10 feet on the lake side, the parapet being 13.5 feet wide.

The breakwater is protected against undermining by a heavy mattress with riprap covering 20 feet wide along each face. On the outer face particularly heavy riprap was used and the depth reduced to about 14 feet. On the inside the mattress was covered with small stone, and the depth made at least 20 feet for the mean stage. The cribs were constructed at the contractor's yards in Buffalo and towed to Fairport, a distance of 150 miles. One crib was injured in transit to such an extent that it was necessary to reduce its length to 180 feet.

The contractor experienced considerable difficulty in securing suitable timber for the work, and the final completion of the contract was delayed about six weeks beyond the stipulated time (November 15, 1900) on this account.

The cost of this section of the breakwater, including general administration expenses and inspection, was $102,119, or nearly $125 per linear foot.

Fairport Harbor has always been especially subject to the formation of bars, tending to close the channel during the winter and spring of each year. Usually two bars are formed, one at or near the outer end of the piers and the other out from 1,200 to 1,600 feet in the lake. The depth on the bars is sometimes reduced to 12 feet, and this depth only available in a narrow channel. In this respect it is said that the conditions at Fairport are worse than at any other harbor on Lake Erie.

The primary object of the arrangement of the breakwater proposed in the approved project is to prevent the formation of these bars in the channel, and to thus obviate the necessity for dredging every season. In the present case, however, the short length of breakwater already constructed failed to accomplish any material benefit, and a bar of somewhat unusual proportions was in evidence at the end of the piers at the time navigation opened up this spring. This unfavorable result may have been due to the inadequate length of the structure now completed, which will ultimately be 2,050 feet long.

Between September 15 and October 11, 1900, 13,500 cubic yards of material was dredged from the outer bar, at a cost of about $3,000, under a special contract with Edward J. Hingston, of Buffalo, N. Y. The work was reported by the inspector in charge to provide a depth of 21 feet in a channel suited to the needs of commerce.

In the spring of 1901, notwithstanding the extensive dredging operations during the preceding year, and the construction of about forty per cent of the west breakwater, the usual conditions were found to exist, and a depth of only 14 feet was reported at the end of the outlined channel. Shortly after the opening of navigation a violent flood in the Grand River moved this bar out about 300 feet and generally improved the depth in the harbor. The conditions, however, were not satisfactory to the shipping interests, and in April the United States dredge *Maumee* was sent to Fairport, and during the months of April and May removed about 30,000 cubic yards from both bars and again provided a depth of fully 21 feet.

Under your direction I have recently made an examination of the piers at Fairport with a view to repairing the damage done in September last to the end of the east pier by the Steamer *Spokane*, and also to determine the extent and probable cost of the necessary or justifiable repairs to old cribs. As a result of this examination, I reported to you, under date of June 27, that the end of the east pier could be restored to its original shape and condition at a cost of about $1,825, and that a very desirable and necessary improvement in the condition and appearance of the cribs constructed since 1893 could be effected by repairing the decking and sheathing the inside face with oak plank to a depth of 5 feet below mean lake level, at a cost of about $3,725.

The repairs suggested will add materially to the life and usefulness of the structures and still leave available sufficient funds for maintaining the channel until another appropriation is available for the harbor.

Very respectfully,

G. T. NELLES,
United States Assistant Engineer.

Maj. DAN C. KINGMAN,
Corps of Engineers, U. S. A.

Q Q 10.

IMPROVEMENT OF ASHTABULA HARBOR, OHIO.

For description of location, original condition, and early projects of improvement see page 2679, Report of Chief of Engineers, 1898.

The present project of improvement was adopted in 1896, and provides, in addition to the maintenance of the jetties, for the construction of two breakwaters converging toward the lake, with a space for entrance 400 or more feet wide between the outer ends, which are to be protected by pierheads 50 feet square, to serve as foundations for light-houses of lighted beacons. The west breakwater is to be 1,800 feet long and the east breakwater 1,200 feet long, exclusive of pierheads. The cost as estimated in 1896 was $530,000.

The breakwaters were not designed for the purpose of securing a large sheltered area for anchorage, nor for protecting a harbor frontage on the lake for wharves, but were intended to secure for the harbor, which is within the river mouth, an entrance that will be safe and convenient at all stages of the lake, and will be free from bars, cross currents, and from troublesome seas from waves rebounding from the faces of the breakwaters.

The river and harbor act of March 3, 1899, authorized the construction of this breakwater by continuous contract, and appropriated $430,000 for this purpose. A contract, approved June 22, 1900, was entered into with The Donnelly Contracting Company, of Buffalo, N. Y., for the construction of this work.

Under a previous appropriation a section of the west breakwater 432 feet in length was constructed. This was built of timber cribs filled with stone, and with a continuous timber superstructure. The new breakwater for which contract was made provided for a structure entirely of stone except as to the pier heads, which were of timber cribs below water and concrete above. The portion now completed will remain as it is until the superstructure begins to decay, when this will be removed and the whole covered with large stone to conform in shape and appearance to the rest of the breakwater.

The shore to the westward of this harbor is composed of sand, and the shore line is constantly advancing by accretion of sand washed in by the waves. The dry sand from this extensive beach area is lifted and carried by the prevailing westerly winds, and has heaped itself upon the west jetty until it has completely buried it within the shore line, whence it is carried over into the channel, constantly tending to reduce its depth and width. I think it desirable that the United States should acquire title, by condemnation or purchase, to at least a half mile of the lake shore to the westward of the jetties, in order that this movement of sand might be arrested or controlled by a plantation of willows or by suitable sand fences. These things can not be built or maintained while the land remains in the possession of private individuals.

The jetties at Ashtabula are very short, and do not extend out into the lake beyond the influence and effect of the sediment which is lifted in the shallow water and held in suspension temporarily under the action of storm waves. A deposit constantly tends to form outside the jetties and to reduce the navigable depth to less than that desired. Possibly the proposed breakwater will do away with this difficulty. At least it is hoped that it will diminish it, but it may be necessary to connect the jetties with the breakwater by a tight structure in order to cut off entirely the current around the jetty heads.

At the beginning of the fiscal year 1901 the channel was obstructed by a bar, and as no money was available other than that tied up in the contract, an allotment of $3,000 was made from the appropriation of "emergencies in river and harbor works," act of June 6, 1900, for the removal of this bar by dredging, This was done during the summer, about 12,000 cubic yards of material being removed. On the opening of navigation in the spring of 1901, it was found that the bar had re-formed, and another allotment of like amount was made from the same appropriation and similarly applied, and the channel dredged to the full width between the jetties to a depth of 20 feet across the bar out to deep water.

The jetties are in a ruinous condition, and are in great need of immediate repairs. In the Report of the Chief of Engineers, 1900, it was estimated that the cost of maintaining, repairing, and rebuilding of jetties, revetment of bank, and maintenance of channel for one year would amount to $205,520. This amount is urgently required, and could be advantageously expended in one year.

But little progress was made by the contractors. The cribs for the two pierheads are in course of construction at Buffalo, and will be ready to be towed to Ashtabula and sunk probably during the month of July. Under thier contract they will have until about the middle of the summer of 1905 to complete the work, but in my judgment it will be pushed more rapidly than the contract requires and will probably be completed at least a year earlier. I think that provisions should be made in the estimate for such a rate of progress at least.

The commerce of Ashtabula continues to increase, and its increase for the year 1900 was greater than that of any other harbor in the district. The total receipts and shipments of that year amounted to more than 5,750,000 tons, an increase of over 1,100,000 tons over the previous year.

For a detailed description of the work done during the present fiscal year, attention is respectfully invited to the report of Junior Engineer Howard E. Smith, which is transmitted herewith.

Ashtabula Harbor is in the collection district of Cuyahoga, Ohio. There is a fixed white light of the fifth order, varied by flashes, and a fog signal operated by steam upon the west pier; also a beacon near the shore to form a range with the other light for vessels approaching the harbor.

Money statement.

July 1, 1900, balance unexpended		$152,991.83
Amount appropriated by sundry civil act approved March 3, 1901		2,000.00
Allotments, emergency river and harbor act June 6, 1900		6,000.00
		160,991.83
June 30, 1901, amount expended during fiscal year		6,549.94
July 1, 1901, balance unexpended		154,441.89
July 1, 1901, outstanding liabilities		269.28
July 1, 1901, balance available		154,172.61
July 1, 1901, amount covered by uncompleted contracts		407,410.11
Amount (estimated) required for completion of existing project		318,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901:		
For works of improvement	$300,000.00	
For maintenance of improvement	205,520.00	
		505,520.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

Amount and date of all appropriations for improving the harbor of Ashtabula, Ohio.

May 26, 1826	$12,000.00	June 18, 1878	$12,000.00
May 19, 1828	2,403.50	March 3, 1879	9,000.00
March 3, 1829	6,940.25	June 14, 1880	20,000.00
March 2, 1831	7,015.00	March 3, 1881	20,000.00
July 3, 1832	3,800.00	August 2, 1882	20,000.00
March 2, 1833	3,400.00	July 5, 1884	22,500.00
June 28, 1834	5,000.00	August 5, 1886	30,000.00
March 3, 1835	7,591.00	August 11, 1888	25,000.00
March 3, 1837	8,000.00	September 19, 1890	40,000.00
July 7, 1838	8,000.00	July 13, 1892	70,000.00
June 11, 1844	5,000.00	August 18, 1894	75,000.00
August 30, 1852	10,000.00	June 3, 1896	50,000.00
March 3, 1853	42.60	March 3, 1899	50,000.00
June 23, 1866	24,708.82	June 6, 1900	110,000.00
March 2, 1867	54,000.00	June 6, 1900 (allotments)	6,000.00
March 3, 1871	15,000.00	March 3, 1901	2,000.00
June 10, 1872	15,000.00		
March 3, 1873	16,000.00	Total	830,401.21
June 23, 1874	35,000.00	Expended to June 30, 1901	675,959.32
March 3, 1875	25,000.00		
August 14, 1876	5,000.00	Unexpended July 1, 1901	154,441.89

CONTRACT FOR CONSTRUCTING A PART OF WEST BREAKWATER FOR IMPROVING HARBOR AT ASHTABULA, OHIO, IN FORCE DURING THE FISCAL YEAR ENDING JUNE 30, 1901.

Name of contractor: The Donnelly Contracting Company, Buffalo, N. Y.
Date of contract: May 15, 1900.
Date of approval: June 22, 1900.
Date of commencement: October 1, 1900.
Date of completion: Continuous contract.

COMMERCIAL STATISTICS.

The following statistics for the year 1900 relative to the commerce of the harbor of Ashtabula, Ohio, were compiled from information furnished by the collector of customs and others:

Receipts.	Tons.	Shipments.	Tons.
Iron ore	4,160,943	Coal (bituminous)	1,593,223
		Coke	581
		Timber (oak)	40
		Miscellaneous	615
Total	4,160,943	Total	1,594,459

Total freight tonnage:	
1900	5,755,402
1899	4,652,232
Increase	1,103,170

Vessels.	Number.	Tonnage.
Entering	1,799	2,620,904
Departing	1,814	2,628,032
Built	2	45

Total registered tonnage (vessels entering and departing):	
1900	5,248,936
1899	4,477,983
Increase	770,953

Draft of largest vessels using harbor, 18½ feet. Largest vessels do not load to full depth. No new vessel lines established during the year.

NOTE: A large number of the latest boats are built to load to a 20-foot draft.

REPORT OF MR. HOWARD E. SMITH, JUNIOR ENGINEER.

ASHTABULA, OHIO, *July 5, 1901.*

MAJOR: I have the honor to report on work done for the improvement of Ashtabula Harbor during the year ending June 30, 1901, as follows:

A contract has been in force since May 15, 1900, with The Donnelly Contracting Company of Buffalo, N. Y., for the construction of two stone breakwaters and of two pier heads of timber, surmounted with concrete, to terminate the outer ends of the breakwaters.

No work has yet been done on the breakwaters, though it is expected that the work will be commenced within a very brief time after the opening of the next fiscal year.

The contractors began to frame the pier heads at their yards in Buffalo, N. Y., on October 22, 1900. Work was stopped in the latter part of December for the remainder of the winter and was resumed April 9, 1901. At the close of the fiscal year pier heads are not completed; as soon as completed they will be towed to Ashtabula.

A dredge was employed from July 28, 1900, to September 19, 1900, making a channel through the bar that had formed about 500 feet northward from the ends of the piers. The work proceeded with unusual slowness because of the frequency of storms and rough seas resulting therefrom; 1,000 cubic yards had been dredged when the contract was terminated.

On April 30, 1901, a survey was made of the channel between piers and of the channel leading to the deep water of the lake. It was found that the channel had become much contracted and the sides of the channel made irregular by reason of the drifting of sand from either side. A minimum depth of water of 18 feet was found in this channel, referred to mean level of lake.

Under careful pilotage boats were able to enter and to leave the harbor, but the larger boats could not be loaded to full depth. An agreement was entered into May 10, 1901, to do the dredging. Work was commenced May 15 and continued until June 12, resulting in the restoration of a channel of 20 feet depth, and width equal to the width between piers.

A brief statement follows of the condition of the piers and needed repairs for same:

The outer end of the west pier is greatly in need of repair. The stone filling is entirely emptied from the outer pocket and partially emptied from the next pocket, presumably through an opening or openings in the bottom of the pier. About 225 tons of stone will be required to replace that which has been lost, but as the stone has been lost and replaced once before since the pier was first filled, repair will be necessary before it is filled again. Otherwise a repetition of the loss may be expected.

The outer section of the west pier, 240 feet long, is in fairly good condition, except as above noted. The superstructure of the remainder of the west pier is generally in very poor condition. In many instances deck planks and floor stringers are nearly or entirely removed by decay. The side wall on the west side of pier is generally well preserved, but the side wall on the east side is badly decayed and entirely gone to a depth of 3 or 4 feet from the top of pier in several places.

That portion of the east pier north of the canal of the Lake Shore and Michigan Southern Railway is in good condition. The superstructure of the east pier south of the above-mentioned canal is entirely in ruin. It is probably that the substructure is entire and is of service in retaining the bank of the channel, but otherwise the pier is of no use, being removed by decay to water level.

The west pier is in need of extensive repairs through a length of 1,820 feet.

Very respectfully,

Howard E. Smith,
United States Junior Engineer.

Maj. Dan C. Kingman,
Corps of Engineers, U. S. A.

Q Q 11.

IMPROVEMENT OF CONNEAUT HARBOR, OHIO.

The project adopted in 1896 for improving the harbor includes the construction of two breakwaters with pierheads on which to place beacons, the extension of east jetty 450 feet and west jetty 150 feet, the rebuilding of a section 480 feet long of west jetty near the shore, and the removal of rock and other material between jetties and in protected area to a depth of 20 feet.

The estimate included the following items of cost:

Four hundred and eighty feet of jetty on west side, between shore and new jetty built in 1894, at $88	$42,240
To extend east jetty 450 feet and west jetty 150 feet to 600 feet, at $100	60,000
West breakwater 1,250 feet long; east breakwater 1,050 feet long, including pierheads, at an average cost of $150 per foot	345,000
Removal of rock in channel to depth of 20 feet, at $2 per cubic yard	22,000
Dredging sand, gravel, and stones to depth of 20 feet	20,000
Contingencies of all kinds	40,760
Previously expended on east and west jetties	80,000
Total	610,000

Since the estimate was made prices of materials and labor have been considerably increased, but as an offset the rock, which was less in amount than anticipated, and part of old jetty have been removed to a depth of 20 feet by the Pittsburgh, Bessemer and Lake Erie Railroad Company, under authority from the Secretary of War. Part of the dredging has also been done without cost to the United States. Owing to the rock underlying the sand along the line of breakwater some items included in original estimate would cost less than anticipated. The estimate of cost is therefore considered sufficient to complete the work.

Previous to June 3, 1896, a length of 400 feet of east jetty, and 600 feet of west jetty had been constructed, and a revetment of piling and stone had been extended inside the shore line on east side over a length of 526 feet.

In 1897 a section of west breakwater 282 feet long was constructed, beginning at the end nearest shore. Since 1897 all expenditures have been for maintenance of channel to a depth of 20 feet and width of 200 feet.

The last annual report reads as follows:

> The arrangement of breakwaters at Conneaut was designed as a modification of the system of parallel piers, with especial reference to checking or preventing the formation of sand bars at the harbor entrance. The direction of the breakwaters with reference to the shore line and to the winds which prevail during the storms on the lake are such that all seas having sufficient force to move the sand along on the bottom will in general be deflected from the outer ends of breakwaters and will chase along the faces toward the shore.
>
> Such a deflection of the seas will necessarily result in moving the sand away from the entrance and toward the shore along oblique lines diverging from the channel. The reacting seas and currents will also be away from the harbor entrance, which is to be between contours of 25 feet and 26 feet depth in the lake. These conditions are expected to result in a reliable depth of water, reduction to a minimum of the difficulty and danger attending the entrance of vessels during stormy weather, and a small protected area outside of the harbor proper which will serve many purposes of safety and convenience.
>
> The plan contains complete arrangements for the erection of beacons on the pierheads at outer ends of breakwaters.

If the opening of the breakwater is of sufficient width, say not less than 500 or 600 feet, and is placed upon a line in prolongation of the jettied channel, there is no doubt that the entrance to the harbor will be made very much safer and easier for vessels under all conditions. I do not feel sure, however, that the construction of the proposed breakwater will entirely do away with the formation of the sand bar beyond the end of the jetties. These jetties are very short and do not extend out into the lake beyond the influence of the sand which is lifted and held temporarily in suspension by the action of the waves during storms. I think that it may be necessary, in addition to the works proposed, to connect the jetties each with its corresponding wing of the breakwater by some tight construction that will entirely cut off the flow of water around the jetty heads.

At the beginning of the fiscal year a contract with James B. Donnelly, of Buffalo, N. Y., was in force for continuing the construction of the west breakwater. The design of the new portion, for which the contract was let, was essentially the same as that of the part already built, that is to say, it consisted of timber cribs filled with stone and sunk upon a prepared foundation, and surmounted by a continuous timber superstructure, the intention being to replace all of the timber above water, when it became necessary, by an equivalent structure of concrete.

A portion of the foundation for the new work was prepared in the fall of 1900, and two cribs were built by the contractor at Buffalo, N. Y. One of them was towed to Conneaut, but in attempting to tow the other it was so strained and injured that it was necessary to tow it back to Buffalo for repairs. Upon examination it was found best to cut it in two, repair it, and sink it in two parts. This was accordingly done in a satisfactory manner. Four cribs in all have been built and sunk by the contractor, but the superstructure has not yet been built upon them. When this is done it will complete the present contract and exhaust the funds now available. The total length of west breakwater will then be about 1,032 feet, which will leave, according to the project, about 222 feet, including the pierhead, to be completed. No work at all has been done upon the east breakwater.

In the spring of 1900 it was found that an extensive bar had formed across the channel outside of the jetties which was a serious obstruction to navigation. All of the funds appropriated for the harbor had been tied up in the contract for extending the breakwater. Fortunately it was possible to procure an allotment from the general appropriation for "Emergencies in river and harbor works," act of June 6, 1900. Such an allotment, $3,000 in amount, was obtained July 2, 1900, and was applied to dredging through the bar and removing deposits from between the jetties. About 16,000 cubic yards of material was dredged in all and the channel restored to its full depth.

At the opening of navigation in the spring of 1901 it was discovered that the bar had again re-formed and another allotment from the same appropriation, $2,500 in amount, was made. This was expended in dredging between May 24 and June 7, and 10,057 cubic yards of material was removed, securing a channel across the bar of a width equal to that between the jetties and affording a full depth of 20 feet outward to the equivalent depth in the lake.

If this emergency appropriation had not been available the bar would have had to be removed by private enterprise or the harbor temporarily abandoned. This demonstrates the extreme desirability of always having available for such harbors a sufficient sum of money for maintenance, or, what would perhaps be better, having always available in the district a powerful dredge like that described elsewhere in this report.

The commerce of the harbor of Conneaut exhibits a growth which is quite phenomenal. In 1893 the commerce amounted to nothing. The depth of water in the harbor was sufficient only for small fishing boats. In 1900 the commerce amounted to more than 3,300,000 tons, an increase of nearly three-quarters of a million tons over that of the previous year. Such a large and important commerce seems to justify a rapid prosecution to completion of the works of improvement proposed for this place.

For a detailed description of the work done during the present fiscal year attention is respectfully invited to the report of Junior Engineer Howard E. Smith, which is transmitted herewith.

Conneaut Harbor is 13 miles east of Ashtabula Harbor and is near the boundary between Ohio and Pennsylvania. It is in the collection district of Cuyahoga, Ohio. There are two fixed white lights of the sixth order upon the west pier at the mouth of the river, forming a range for vessels approaching to enter the harbor.

Money statement.

Allotments, emergency river and harbor act, June 6, 1900		$5,500.00
July 1, 1900, balance unexpended		95,165.56
		100,665.56
June 30, 1901, amount expended during fiscal year		47,450.07
July 1, 1901, balance unexpended		53,215.49
July 1, 1901, outstanding liabilities		16,707.91
July 1, 1901, balance available		36,507.58
July 1, 1901, amount covered by uncompleted contracts		31,838.19
Amount (estimated) required for completion of existing project		407,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901:		
For works of improvement	$200,000.00	
For maintenance of improvement	10,000.00	
		210,000.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

Amount and date of all appropriations for improving harbor at Conneaut, Ohio.

March 3, 1829	$7,500.00	June 23, 1874	$1,500.00
April 23, 1830	6,135.65	March 3, 1875	1,000.00
March 2, 1831	6,370.00	June 14, 1880	6,000.00
July 2, 1832	7,800.00	July 13, 1892	40,000.00
July 2, 1836	2,500.00	August 18, 1894	40,000.00
March 3, 1837	5,000.00	June 3, 1896	40,000.00
July 7, 1838	8,000.00	March 3, 1899	100,000.00
June 11, 1844	5,000.00	June 6, 1900 (allotments)	5,500.00
August 30, 1852	10,000.00		
June 23, 1866	20,513.74	Total	338,129.39
March 2, 1867	10,000.00	Expended to June 30, 1901	284,913.90
April 10, 1869 (allotment)	8,910.00		
July 11, 1870	6,000.00	Unexpended July 1, 1901	53,215.49
March 3, 1873	400.00		

CONTRACT FOR CONSTRUCTING A PART OF WEST BREAKWATER FOR IMPROVING HARBOR AT CONNEAUT, OHIO, IN FORCE DURING THE FISCAL YEAR ENDING JUNE 30, 1901.

Name of contractor, James B. Donnelly, Buffalo, N. Y.
Date of contract, June 28, 1899.
Date of approval. August 1, 1899.
Date of commencement, May 1, 1900.
Date of completion, November 15, 1900.
Extended to July 31, 1901.

COMMERCIAL STATISTICS.

The following statistics for the year 1900 relative to the commerce of the harbor of Conneaut, Ohio, were compiled from information furnished by the collector of customs and others.

Receipts.	Tons.	Shipments.	Tons.
Iron ore	2,863,427	Coal	351,015
Old rails	14,790	Steel rails	77,855
Pier stone	5,336	Bars	487
Miscellaneous	961	Merchandise	18,716
Total	2,884,534	Total	448,073

Total freight tonnage:	
1900	3,332,607
1899	2,611,711
Increase	720,896

Vessels.	Number.	Tonnage.
Entering	976	1,980,794
Departing	977	1,982,123

Total registered tonnage:	
1900	3,962,917
1899	3,570,780
Increase	392,137

Draft of largest vessels using harbor, 20 feet. Largest vessels do not load to full depth. No new vessel lines established during the year.

REPORT OF MR. HOWARD B. SMITH, JUNIOR ENGINEER.

ASHTABULA, OHIO, *July 5, 1901.*

MAJOR: I have the honor to report on work done for the improvement of Conneaut Harbor during the year ending June 30, 1901, as follows:

From July 12, 1900, to August 20, 1900, a dredge was employed to make a channel through the bar that had formed a few hundred feet northward from the ends of the piers. The bar was not as extensive as had formed in previous years. Vessels drawing 18 feet of water were able to enter the harbor under careful pilotage, but the channel was much contracted and not in the usual range between the ends of piers and the deep water of the lake. The dredge was employed also in removing sand in channel between piers that had been driven through the pile revetment. About 16,000 cubic yards of material were removed from channel and from the bar inside.

A contract was executed with Mr. James B. Donnelly, of Buffalo, N. Y., on June 26, 1899, for the construction of about 750 feet of breakwater of timber filled with stone. This work was not commenced until September, 1900, when the contractor began to frame the cribs at his yards in Buffalo, N. Y.

Between September 25 and October 3, 1900, a dredge was employed at Conneaut to remove a thin layer of sand overlying the rock along the line of the breakwater. The depth of sand to be removed nowhere exceeded 2 feet. The minimum depth to rock was 23 feet from mean lake level, and therefore the height of cribs was diminished by 2 feet from what was provided for originally in the contract, making them 22 feet in height.

On October 10, 1900, the work was commenced for preparing the foundation for the cribs by dropping small stones into the channel, already dredged, to make a level bed at a depth of 22 feet below mean lake level. About 500 linear feet of stone foundation were completed at the close of the working season.

At the close of the working season the contractor had completely built two cribs at his yards in Buffalo, N. Y., and had partially completed the other two remaining cribs. The first crib completed was sent to Conneaut, where it remained during the winter and until it was sunk the following spring. The second crib was injured while being towed to Conneaut and it was taken back to Buffalo and repaired, whereby it was made shorter by 14 feet.

The work of preparing the foundation for cribs at Conneaut and of framing cribs at Buffalo, N. Y., was resumed in the spring of 1901. The first crib was sunk May 17, 1901, and the fourth and last crib was sunk June 24, 1901. No work has yet been done on the superstructure, and it is anticipated that the contract will not be completed on July 31, 1901, which is the date fixed for the completion of the contract.

A survey of the channel between piers and between the ends of piers and deep water of the lake was made April 29, 1901. It was found that the bar had formed across the channel a few hundred feet northward from the ends of the piers. The channel was also much contracted and its direction outside of the piers had been changed so that the usual ranges could not be followed by deep-draft vessels in approaching the harbor. Under careful pilotage vessels of 18 feet draft had no difficulty in entering the harbor.

Under an informal agreement dredging was commenced in the channel May 24, 1901, and was continued until June 7, 1901. Ten thousand and fifty-seven cubic yards of material were dredged and a navigable channel of 20 feet depth was restored.

There is appended a brief statement with reference to the condition of the piers.

The outer section of the west pier for a length of 400 feet is generally in good condition. The sheathing at the outer end, however, consisting of 12-inch pine timbers, was torn off in a storm last autumn and should be replaced during the present working season. The remainder of the west pier, 525 feet in length, is in a very dilapidated condition, seeming to require complete renewal. Sand has been driven through this portion of the pier into the river channel in large amounts.

The outer section of the east pier for a length of 600 feet is in a good state of preservation. This, in reality, constitutes the whole of the east pier, for the inner portion, a length of about 500 feet, is a pile revetment supporting a row of sheet piling, which, however, does not prevent the sand from being driven through from the outside into the river channel.

Very respectfully,

Howard E. Smith,
U. S. Junior Engineer.

Maj. Dan C. Kingman,
Corps of Engineers, U. S. A.

Q Q 12.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

SCHOONER BENSON.

On the morning of June 20, 1899, the schooner *Benson*, while being towed from Kelley Island toward Sandusky, Ohio, loaded with 800 tons of coal, sunk in Lake Erie near the outer end of the channel over the outer bar at Sandusky, Ohio.

Its removal was provided for according to law, and an allotment of $2,680 was made for this purpose.

The actual work of removing the wreck was completed prior to June 30, 1900, and a full report of it is given in the Report of the Chief of Engineers for that year, pages 4094 and 4095, but the necessary inspection was not made until after July 1, 1900, and the final payment to the contractor was made September 14, 1900.

The actual cost of removing the wreck, including the cost of inspection, was $2,572.98. The balance of the allotment, $107.02, was then redeposited.

SCHOONER DUNDEE.

In the night of 11th–12th of September, 1900, the schooner *Dundee* was sunk in Lake Erie at a distance of about 13 miles NNW. from the entrance to Cleveland Harbor, Ohio. The length of the schooner was

211 feet; breadth, 35 feet; depth, 16½ feet; gross tonnage, 1,043; built in 1893.

A great deal of trouble was had in locating the wreck. It was finally found lying on an even keel in 68 feet of water, with the bow headed WNW. Two masts remained on the vessel, the cross trees just being awash, and the rigging, together with some other attached parts, formed a dangerous obstruction to navigation.

On October 6, 1900, authority was asked for the removal of the schooner under the provisions of sections 19 and 20 of the river and harbor act of March 3, 1899, and an allotment for the purpose, of $500, was made October 10.

Sealed proposals were invited by circular letter October 19, 1900, for removing the masts and rigging at or near the deck line in such a way as to leave a clear and unobstructed depth of water over all of 30 feet at mean lake level. The proposals were opened October 29, 1900, and the contract was awarded to Charles R. Dittrick, of Glenville, Ohio, to do the work required for the sum of $142. The work of removal was completed December 15, 1900, and an examination was made and showed the full depth required over all portions of the wreck.

The total cost of the work was $500, the greater portion of the expenses being incident and necessary to the location of the wreck and the inspection.

DUMP SCOW BELONGING TO THE L. P. & J. A. SMITH COMPANY, OF CLEVELAND, OHIO.

In the night of September 18-19, 1900, a dump scow belonging to The L. P. & J. A. Smith Company, of Cleveland, Ohio, sunk in the harbor of Cleveland, Ohio, about 500 feet north of the Lake Shore bridge. The wreck was reported and preparations made for its removal, but on the 3d of December, 1900, it was raised and removed by its owners without expense to the United States.

Q Q 13.

EXAMINATION AND PLAN AND ESTIMATE OF COST OF IMPROVING SANDUSKY HARBOR, OHIO.

[Printed in House Doc. No. 120, Fifty-sixth Congress, second session.]

Office of the Chief of Engineers,
United States Army,
Washington, December 1, 1900.

Sir: I have the honor to submit herewith copies of reports dated August 22 and November 17, 1900, with map,[1] by Col. Jared A. Smith, Corps of Engineers, upon preliminary examination and survey, respectively, of Sandusky Harbor, Ohio, with a view to maintaining a channel 21 feet deep at mean lake level, with a width of 400 feet in the approaches to harbor front and 300 feet in the harbor channels, made to comply with requirements of the emergency river and harbor act of June 6, 1900.

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[1] Not reprinted; printed in House Doc. No. 120, Fifty-sixth Congress, second session.

Sandusky Harbor is now being improved by the General Government under a project for obtaining a channel 18 feet deep, 300 feet wide over the bar, and for deepening all channels inside of Cedar Point to 17 feet, with a width of 200 feet. Colonel Smith states that, in his opinion, the improvement contemplated by the present project will, when completed, result in a channel over the bar of as great a capacity as indicated in the above-mentioned item of law, and he presents a plan for further improvement of the Straight and Dock channels with a view to obtaining a depth of 21 feet with widths of 400 and 300 feet, respectively, by dredging and rock removal at an estimated cost of $781,000 and $10,000 annually for maintenance for the first five years.

Colonel Smith states that the previous development of commerce of Sandusky Harbor appears to be sufficient to justify the expenditure which will be required for the proposed increase in width and depth of channels.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

Hon. ELIHU ROOT,
Secretary of War.

PRELIMINARY EXAMINATION OF SANDUSKY HARBOR, OHIO, WITH A VIEW TO MAINTAINING A CHANNEL 21 FEET DEEP AT MEAN LAKE LEVEL, WITH A WIDTH OF 400 FEET IN THE APPROACHES TO THE HARBOR FRONT AND 300 FEET IN THE HARBOR CHANNELS.

UNITED STATES ENGINEER OFFICE,
Cleveland, Ohio, August 22, 1900.

GENERAL: In compliance with instructions in your letter dated June 13, 1900, and requirement of the river and harbor act of June 6, 1900, I have the honor to submit the following report upon a preliminary examination of Sandusky Harbor, Ohio, "with a view to obtaining and maintaining a channel twenty-one feet deep at mean lake level, with a width of four hundred feet in the approaches to harbor front and three hundred feet in the harbor channels."

The first improvement to Sandusky Harbor was made under provisions of the river and harbor act of June 11, 1844, when the channel depths over outer bar ranged from 8 to 9 feet, with a depth of 10 feet inside to and along the city front. Since 1844 improvements have been made at various times and under various projects, most of which have been for deepening the channels by dredging as necessities seemed to require.

In 1888 a project was adopted to dredge a straight channel 200 feet wide and 17 feet deep from the north end of Cedar Point to the east end of the channel, known as the "dock channel," along the city front. The first dredging of the "straight channel" was completed August 31, 1894, but considerable dredging has since been required to maintain the depth and width.

When the straight channel was completed the dock channel had depths ranging from 13 to 14 feet, and the channel over outer bar had a depth of but 16 feet over an indirect course and a width which was generally less than 90 feet.

The latest project, on which work is now in progress, contemplates the dredging of all channels inside of Cedar Point to a depth of 17 feet and a width of 200 feet, and over the outer bar to a depth of 18 feet and width of 300 feet. To obtain and maintain the channel over the outer bar, works of brush and stone to form jetties, spurs, deflection dike, and sill on crest of bar have been devised to confine and direct the currents, so that the main part of the deepening and all of the maintenance will be obtained by natural forces. See report, estimate, and maps in Report of Chief of Engineers, 1898, pages 2709 to 2717.

On the 30th of June, 1900, the improvements had resulted in a channel having depths generally ranging from 18.5 to 21 feet over the outer bar, 17 feet in straight channel to city front, and 16 to 17 feet in dock channel.

From 1892 to 1899 the total of incoming and outgoing freights by water at Sandusky Harbor, as compiled from records in the customhouse, were as follows:

	Tons.		Tons.
1892	385,661	1896	1,383,455
1893	424,280	1897	991,974
1894	600,454	1898	1,190,317
1895	761,208	1899	1,164,172

This large increase in lake freights has been encouraged and made possible by the improvement of channels giving greater width and depth. While the gain has not been uniform, it has in the aggregate been very large and has shown a decided tendency to keep pace with the opportunities afforded.

During the past four years the increase in size of vessels carrying ore, coal, and other heavy freights has been more rapid than the corresponding increase in capacity of the channels at Sandusky Harbor and at a few other places on Lake Erie. The large vessels have, therefore, found considerable difficulty in entering the harbor at certain times, and this condition has prevented the continuation of the increase, which was previously very rapid. In a report of survey at the mouth of Sandusky Harbor, Ohio, dated February 28, 1898 (House Doc. No. 362, Fifty-fifth Congress, second session, and Report of Chief of Engineers, 1898, pages 2709 to 2717), a comment was made upon channel depths, as follows:

> Formerly channels of small depth were sufficient, and most vessels could pass in and out at Sandusky without special difficulty. Most of the lake freights are now carried in large steamers, and the tendency is for all small freighting craft to disappear, because the cost per ton for freight is less in large vessels.
>
> It is evident that at harbors where large vessels can not easily or safely go at all times the shipping of freights will be at such a disadvantage that, save for purely local business, competition with more favored ports can not be maintained, because the force required to carry freight will, like other forces, ultimately find its way along the lines of least resistance.

It is my opinion that the improvements contemplated under the present project will, when completed, result in a channel over the bar of as great a capacity as is indicated in the provision of the act of June 6, 1900, under which this report is submitted. The additional improvements required will therefore be limited to the channels from Cedar Point to and along the city front, a total length of about 17,000 feet. In this connection attention is invited to map on Sheet No. 2, following page 2716, Report of Chief of Engineers, 1898.

The location of Sandusky Harbor makes it easily accessible to the coal mines of Ohio, so that in the year 1899 the shipments of coal alone from Sandusky Harbor amounted to 672,528 tons. Increased facilities for shipping in larger vessels will necessarily result in cheapening of freight rates and an increased shipment of coal to ports on the upper lakes. The same conditions would doubtless result in increased receipts of ore and other heavy freights.

The present project contemplates depths of but 17 feet at mean lake level in channels along city front and thence to the outer bar; the large vessels carrying ore and coal when fully loaded frequently draw 18 feet or even more, and even this limitation is only placed because of the depth of channels through which the vessels must pass.

During a very considerable portion of nearly every season of navigation the lake surface is more or less below the mean level, and this is especially true during the autumn months, when freights are in greatest demand owing to the approaching winter, when navigation is closed because of ice. The surface level is further varied to a very great extent by the force of winds, which cause temporary variations amounting to several feet. It is this difference of level under the force of winds which causes the rapid currents over the bar, which when sufficiently confined and directed are expected to accomplish all that is necessary in enlarging the cross section of the channels.

Channels which nominally have a depth of 17 feet may, for brief periods, have more, but are likely during much of the season to have less, the difference sometimes being as great as 2 feet during a considerable period. It is evident that such channels can not afford certain or safe passage to the largest class of vessels, and equally evident that unless the channels be enlarged their commerce, which had flourished under other conditions, must decline.

The previous development of the commerce of Sandusky Harbor, and the large amount shown from 1896 to 1899, appears to be sufficient to justify the expenditure which will be required for the proposed increase in width and depth of channels.

Very respectfully, your obedient servant,

JARED A. SMITH,
Colonel, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
August 27, 1900.

Respectfully returned to Colonel Smith with request for statement as to estimated cost of survey necessary for preparation of plan and estimate of cost of improvement proposed, provided such survey is required. He is also requested to state whether the expenses incident to such survey will have to be paid from the emergency appropriation of June 6, 1900.

By command of Brig. Gen. Wilson:

A. MACKENZIE,
Lieut. Col., Corps of Engineers.

[Second indorsement.]

U. S. ENGINEER OFFICE,
Cleveland, Ohio, August 30, 1900.

Respectfully returned to the Chief of Engineers.

No additional survey will be required for the purpose of preparing a plan and estimate of cost of improvement proposed.

The surveys and maps have been made at various times in connection with the supervision of works of improvement, so that no expense incident thereto will have to be paid from the emergency appropriation of June 6, 1900.

* * * * * * *

JARED A. SMITH,
Colonel, Corps of Engineers.

[Third indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
September 5, 1900.

Respectfully submitted to the Secretary of War.

This is a report upon preliminary examination of Sandusky Harbor, Ohio (full text of item quoted within), required by the provisions of the emergency river and harbor act of June 6, 1900.

Colonel Smith is of opinion that the improvements contemplated under the present project for this harbor will result in a channel over the bar of as great a capacity as is indicated in the act, and that the improvement required elsewhere to obtain the dimensions mentioned in the act will be limited to the channels from Cedar Point to and along the city front, a total length of about 17,000 feet. He is further of opinion that the commercial interests of the harbor appear to be sufficient to justify the expenditure by the General Government of the money that would be required for the proposed increase in width and depth of the channels.

A survey in the ordinary sense is not required, and I recommend that the local officer be directed to prepare a plan and estimate of cost of improvement, as proposed by him in second indorsement hereon.

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

[Fourth indorsement.]

WAR DEPARTMENT,
September 6, 1900.

Approved as recommended by the Chief of Engineers.

By order of the Secretary of War:

JOHN C. SCOFIELD,
Chief Clerk.

PLAN AND ESTIMATE OF COST FOR IMPROVEMENT OF SANDUSKY HARBOR, OHIO, WITH A VIEW TO MAINTAINING A CHANNEL 21 FEET DEEP AT MEAN LAKE LEVEL, WITH A WIDTH OF 400 FEET IN THE APPROACHES TO THE HARBOR FRONT AND 300 FEET IN THE HARBOR CHANNELS.

United States Engineer Office,
Cleveland, Ohio, November 17, 1900.

General: Complying with instructions in your letter dated September 14, 1900, and with the provisions of the emergency river and harbor act of June 6, 1900, I have the honor to submit the following report, with an estimate of cost of improving the harbor of Sandusky, Ohio, "with a view to obtaining and maintaining a channel twenty-one feet deep at mean lake level, with a width of four hundred feet in the approaches to the harbor front and three hundred feet in the harbor channels."

My preliminary report, dated August 22, 1900, indicated quite fully the conditions of channel, present and prospective, under projects of improvement heretofore completed or undertaken. These projects afford channels of but 17 feet depth in the bay at mean lake level. These depths are always less in the autumn months, when the lake surface is invariably lower than in the spring. In some of the recent seasons of navigation the water depths in the months of October and November have been 1 to 2 feet lower than the mean level.

The tendency to carry all heavy freights in large vessels, and for all small vessels to be withdrawn, was discussed in my preliminary report, and it was also shown that the tendency to a rapid increase in amount of freights at Sandusky Harbor had been somewhat checked by the lack of sufficient depth in the channels.

The annual average of freights by water at this harbor for four years, 1896 to 1899, inclusive, exceeded 1,182,000 tons, and there is strong indication of a large increase in the amount when better channels are provided. The channels to be so provided must necessarily extend along the entire line where the heavy freights are to be received and shipped by water.

The present project provides for constructing works of stone upon brush mattresses to direct and confine the channel over the outer bar, with a view to obtaining and maintaining a sufficient width and depth by the scour of currents induced by winds. The results thus far, due to the construction of three-fifths of one of the jetties, have been sufficient to justify the conclusion that the completion of the works projected will result in an ample channel. It is even recommended that in the extension of the jetty which has been commenced on the west side an offset of 50 or more feet be made to widen the distance between jetties, and thus increase the room and prevent too great a concentration of currents, which have been at times found very strong.

The channels in the bay have heretofore been designated as the "straight channel" and the "dock channel," the latter of which is divided into east and west sections for convenience of designation and because the material in the two sections is quite different.

The straight channel is one of the approaches to the harbor front. It extends from the deep part of channel opposite Cedar Point, known as the "deep hole," to the east end of dock channel, and is about 1¾ miles in length. The dock channel along city front is about 1½ miles long, of which the sections are equally divided. There are no currents in the bay which can be confined or directed in such way as to produce nor to maintain the channels required. The only method of obtaining the result is therefore by removing the earthy material by dredging and the rock by blasting and dredging.

In the straight channel the material is of sand and mud, readily dredged. In the east section of dock channel material is much the same as in straight channel, but somewhat harder, and the west end is underlain with rock; in the west section the material is quite hard; the eastern part is underlain with rock, and occasional bowlders, or, rather, large pieces of stone, are found.

The entire area of channels is underlain with limestone, but with the exception of the small area near middle of dock channel the surface of the rock is below the grade of 21 feet, to which it is proposed to dredge.

The removal of this rock to the grade of 21 feet below mean lake level will be very expensive, because it can not be dredged without blasting, and its qualities are such that it must be removed to 1 or more feet below grade to insure the required depth throughout. If the earthy material be removed from the rock where it projects above the grade of 21 feet, it will still leave a channel having a minimum depth of 18 feet at mean lake level, and it may be a matter of some question whether the entire removal of the rock to grade will be justified by probable results.

In estimating the amount of rock to be removed it has been taken to a grade of 22 feet below mean lake level, because practically that would be necessary and a smaller quantity would be quite overbalanced by an increase of price.

To accompany this report there is forwarded in a separate package a small tracing of the map of part of Sandusky Bay showing the bar and channels with location of improvements now in progress and proposed.

The following estimate is submitted for the improvements here proposed, and which, with exception of rock removal, are recommended:

Dredging straight channel approach, 21 feet deep, 400 feet wide on the bottom, with slopes of 1 on 2, 1,100,000 cubic yards, at 15 cents	$165,000
Dredging east section of dock channel 300 feet wide to depth of 21 feet, or to surface of rock, 250,000 cubic yards, at 18 cents	45,000
Dredging west section of dock channel, same as east section, 750,000 cubic yards, at 30 cents	225,000
Add for all contingent expenses about 5 per cent	21,000
Total	456,000

Estimate of quantities is for scow measurement.

The following is the estimated cost of removing the rock, as before mentioned:

65,000 cubic yards, at $5	$325,000

It is possible that the rock may be removed by contract at a less cost than is here estimated, but a lower estimate is not considered prudent.

The question of maintenance of such channels by dredging is one upon which there are few, if any, reliable data upon which to base an estimate. It may, however, be reasonably assumed that most of the maintenance will be within the first five years after completion, and that during that time it will not cost to exceed $10,000 per annum.

Very respectfully, your obedient servant,

JARED A. SMITH,
Colonel, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

Q Q 14.

EXAMINATION AND PLAN AND ESTIMATE OF COST OF IMPROVING CLEVELAND HARBOR, OHIO.

[Printed in House Doc. No. 118, Fifty-sixth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, November 30, 1900.

SIR: I have the honor to submit herewith copies of reports dated August 17 and November 17, 1900, with photographs,[1] by Col. Jared A. Smith, Corps of Engineers, upon preliminary examination and survey of Cleveland Harbor, Ohio, with a view to the further improvement of said harbor, first by such additional construction or extension as may be necessary to provide a safer and better entrance for vessels at the main entrance to the breakwater in said harbor; second, to provide such additional harbor room as may be found

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[1] Not reprinted; printed in House Doc. No. 118, Fifty-sixth Congress, second session.

necessary by an extension eastward of the breakwater now under construction in said harbor, made to comply with requirements of the emergency river and harbor act of June 6, 1900.

Cleveland Harbor is now under improvement by the United States; and Colonel Smith is of the opinion that the harbor is worthy of further improvement in the manner indicated in the act above mentioned. He presents projects for such improvements as follows:

1. For construction of breakwater, etc., necessary to provide a safer and better entrance, estimated to cost according to one plan	$695,587
According to alternate plan	1,001,727
2. For extension eastward of breakwater now under construction, to provide additional harbor room according to one plan	3,785,869
According to alternate plan	3,853,069

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

Hon. ELIHU ROOT.
Secretary of War.

PRELIMINARY EXAMINATION OF CLEVELAND HARBOR, OHIO, WITH A VIEW TO THE FURTHER IMPROVEMENT OF SAID HARBOR, FIRST, BY SUCH ADDITIONAL CONSTRUCTION OR EXTENSION NECESSARY TO PROVIDE A SAFER AND BETTER ENTRANCE FOR VESSELS AT THE MAIN ENTRANCE TO THE BREAKWATER, AND, SECOND, TO PROVIDE SUCH ADDITIONAL HARBOR ROOM AS MAY BE FOUND NECESSARY BY AN EXTENSION EASTWARD OF THE BREAKWATER NOW UNDER CONSTRUCTION.

UNITED STATES ENGINEER OFFICE,
Cleveland, Ohio, August 17, 1900.

GENERAL: I have the honor to submit the following report of preliminary examination of Cleveland Harbor, Ohio, as indicated in your letter dated June 13, 1900, and in compliance with requirement of the act of Congress approved June 6, 1900, "Making provisions for emergencies in river and harbor works, for certain surveys, and for the diversion of certain appropriations or modification of provisions heretofore made."

The report for Cleveland Harbor is required by the act before mentioned—

> With a view to the further improvement of said harbor: First, by such additional construction or extension as may be necessary to provide a safer and better entrance for vessels at the main entrance to the breakwater in said harbor; second, to provide such additional harbor room as may be found necessary, by an extension eastward of the breakwater now under construction in said harbor.

The commercial importance of Cleveland Harbor is very great. In 1899 the number of vessels reported by the collector of customs as entering Cleveland Harbor was 4,129, and as leaving the harbor 4,221. Nine vessels were built at Cleveland Harbor with an aggregate tonnage of 23,482 tons.

The amount of freights by water as reported through the agency of the custom-house was in 1899, 7,390,924 tons. The statistics of entries and departures, and of freights carried, are necessarily incomplete to some extent, because many of the vessels are not required to report at the custom-house, and the numerous tugs passing in and out, together with many other small craft are not likely to be noticed in custom-house reports.

Were the freights as reported to be loaded into cars at a rate which would make 1,000 pounds per linear foot of the train, which is probably more than an average rate of load for miscellaneous freights, the train thus loaded would extend about 2,800 miles, which is more than a hundred miles farther than from Cleveland, Ohio, to San Francisco, Cal.

Of this large amount of freight more than three and a half millions of tons were of iron ore, of which a very considerable portion does not leave Cleveland until it has been transformed and served a purpose as the basis for many great industries.

The river and harbor act of June 3, 1896, contained a provision for Cleveland Harbor, as follows:

> *And provided also*, That the Secretary of War be directed to cause a survey to be made of the said breakwater as heretofore planned, with a view of determining the advisability of changing the plan thereof so as to abandon the proposed construction of the eastern shore arm, and in lieu thereof extending the said breakwater eastwardly in a general direction parallel with the shore.

This question of modifying previous plans arose because of the apparent necessity for a future eastward extension of the harbor and the belief that such extension would be accomplished with greater facility and better results if the part of breakwater now under construction were to be on a straight line instead of having an angle and a change of direction shoreward as planned.

The modification of plans was not recommended, because a complete survey resulted in the conclusion that the previous plan of breakwater would result in a better protection from northeast storms in the adjacent anchorage and wharf frontage and would facilitate rather than interfere with the future extension eastward should it be found necessary.

Certain questions discussed in the report which was printed in Doc. No. 128, Fifty-fifth Congress, second session,[1] are so pertinent at this time that an explanation followed by an extract from the report are here given.

In order to obtain information regarding the commercial interests and necessities of Cleveland Harbor bearing upon the subject then in hand, a letter was addressed under date of June 30, 1897, to the president of the Cleveland Chamber of Commerce, from which the following is a copy:

UNITED STATES ENGINEER OFFICE,
Cleveland, Ohio, September 30, 1897.

DEAR SIR: The act of Congress known as the river and harbor act of June 3, 1896, contained a clause regarding Cleveland Harbor in the following words:

"That the Secretary of War be directed to causé a survey to be made of the said breakwater as heretofore planned, with a view of determining the advisability of changing the plan thereof so as to abandon the proposed construction of the eastern shore arm, and in lieu thereof extending the said breakwater eastwardly in a general direction parallel with the shore."

In a separate roll I hand you a blue-print map of Cleveland Harbor, which will illustrate the present extent of the breakwater and the question raised in regard to its future extension.

The east breakwater now has a length of 2,494½ feet. The present plan of this breakwater contemplates a length of 3,000 feet, measured on a straight line from the east side of harbor entrance, and thence a distance of 2,000 feet obliquely toward the shore to a point approximately on the prolongation of the west side of Muirson street, and about 2,750 feet outside of the shore line.

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[1] Reprinted in Annual Report of the Chief of Engineers for 1898, Part IV, page 2724, et seq.

I am now required to submit to the Chief of Engineers a report upon the advisability of modifying the plan of the harbor in such manner that the entire eastern breakwater shall be on one continuous straight line. This is not directly a question of engineering so much as of expense and of public policy in the interest of the varied commerce and industries of Cleveland, of which the chamber of commerce is the representative body. The question is therefore submitted in the hope of receiving in reply some information which will assist in formulating a complete and conclusive report. I beg leave, however, to make the following suggestions:

First. From 1876 to 1883 the United States constructed a breakwater on the west side having a total length of more than 7,000 feet and protecting an area on the west side of which the shore line is slightly more than 1 mile in length. The west breakwater has been completed nearly fourteen years, during which time the United States has expended a considerable sum annually for maintenance, and it is now under the necessity of expending about $425,000 in order to renew parts which are decayed or worn. Meantime, the depths in the protected area have been greatly reduced by various causes.

Up to the present time no wharf or pier for business purposes has been constructed within the area thus protected, which has been year by year losing its depth of water.

Second. The length of shore line and the area to be protected on the east side, according to present plans, are each nearly as great as the corresponding parts on the west side, although only the part west of Seneca street is now available for commercial business because of the frontage owned by the city for park purposes and by the United States for the Marine Hospital. Next east of Muirson street comes the new Lakeside Hospital.

If the breakwater were to be limited to the length now authorized there would be no hesitation in deciding that the plan heretofore adopted affords far better protection than could be obtained by the same length in one straight line. The question now raised, therefore, seems to imply that the commercial interests of Cleveland are such as to justify the United States in extending the breakwater farther eastward than is now planned, and that such extension should be on a continuous straight line.

Any business which would require a protection beyond what is contemplated in present plans must necessarily be located east of Canfield street, and the farther the protection is from the shore the greater the length required to afford shelter from northeast storms. The original cost of the breakwater may be estimated at $160 per linear foot, and in twenty years the cost of maintenance will increase that amount about 50 per cent.

It seems pertinent, therefore, to ask:

First. What commercial enterprises are now in operation on the lake front of Cleveland east of Canfield street whose business would be greatly facilitated or increased by the extension of the breakwater sufficiently far to protect their respective water fronts?

Second. To what extent is it certain that a farther extension of the breakwater eastward would develop new enterprises?

Third. If all the benefits to be derived from an extension of the breakwater beyond the limits of present plans were to accrue directly to the United States, would they be sufficient to justify the expenditure as a financial investment and enterprise?

Fourth. In consideration of the fact that the breakwater already covers a large area and shore line on the west side, of which no advantage has thus far been taken to develop commercial enterprises on the lake front, and of the fact that an additional expenditure of $1,354,000 has been authorized by Congress, is it justifiable at present to submit a recommendation for the modification now proposed, with all its direct and implied results?

Fifth. Should the commerce of Cleveland at present or at some future time be found to justify the expense of additional harbor room east of the limits heretofore adopted, would it not be better to construct an independent breakwater, covering only the space required, rather than to extend the present breakwater on the same line, resulting in a harbor which would leave room to develop a considerable sea from the northeast within its own limits?

Thanking you in advance for any consideration and reply which may be given to the questions here presented, I am,

Very respectfully, yours,

JARED A. SMITH,
Colonel, Corps of Engineers, U. S. A.

Mr. W. R. WARNER,
President the Cleveland Chamber of Commerce, Cleveland, Ohio.

THE CLEVELAND CHAMBER OF COMMERCE,
October 20, 1897.

SIR: I have to transmit herewith a copy of the report submitted to the chamber of commerce, at its general meeting held last evening, by the committee on harbor and docks and the executive committee of the maritime board, to whom your letter of September 30, addressed to President Warner on the subject of the extension of the breakwater eastward, was referred. As indicated in the report, the chamber will be very glad to supplement any general statements embraced in the report by more definite and specific information if you will kindly indicate what would be desirable.

At the same time I desire to advise you that a resolution of thanks was unanimously adopted by the chamber, expressive of its sincere appreciation of the courtesy and consideration shown to the chamber by you in inviting its official interest upon this important matter.

Again thanking you,

I am, very respectfully,

RYERSON RITCHIE, *Secretary.*

OCTOBER 16, 1897.

Your committee on harbor and docks, and the executive committee of the maritime board, have met and considered the letter referred to them by your board of directors from Col. Jared A. Smith, United States engineer in charge of the harbor improvements at Cleveland, and the matters therein brought forward. After full consideration of the subject it is recommended that a reply be addressed to Colonel Smith, the substance of which shall be to recommend and urge, on behalf of the commercial interests of the city of Cleveland represented by this chamber, the extension of the breakwater easterly, preferably upon the line of the present breakwater extended. The reasons for this are, briefly, as follows:

The breakwater at Cleveland was begun under a plan submitted in 1875, the modification of which, under which the east breakwater is now projected, was made in 1888, the design then being to limit the breakwater by a shore arm at a point about opposite the foot of Muirson street. The enlargement of the original plan was made in 1888 upon a showing of the remarkable increase in the business of the district, in the commerce of the lakes generally, and in the size of vessels which were the instruments of this traffic. It was shown that in 1888 there were ships being built of the then great length of 310 feet, with a carrying capacity of 2,800 tons. Since that time, or during the past ten years, the increase in all these respects has been beyond the greatest expectations of anyone connected with the lake commerce at that time.

For the year ending June 30, 1897, more steam tonnage was built on the lakes than in all other ports of the United States combined. There are to-day many more vessels of a tonnage of 1,000 tons and upward on the lakes than in the entire American merchant marine exclusive of the Great Lakes. There are many ships over 400 feet in length. Steamers are now building of 450-feet keel, and one is about to be built of 500 feet, and it is undoubtedly true that the demands and economies of lake commerce will necessitate the continued construction of vessels of great dimensions. A contract was recently let for a steamer guaranteed to carry 6,500 tons and for 2 consorts guaranteed to carry 7,000 tons each. Harbors, shipping facilities, and breakwaters which were entirely adequate ten years ago are now insufficient. So far as the purposes of a harbor of refuge are concerned, the breakwater, if completed as now projected, will be entirely inadequate to the demands of commerce carried on in vessels more than double the size of those in use ten years ago.

The enlargement and deepening of channels by the Government has so greatly increased the facility with which cargoes are carried in large vessels that the average rate for carrying a ton per mile on the lakes in 1897 will scarcely exceed one-tenth of the cost on the most favored railroad in the United States. Recent developments in business have increased the ore and other shipments by lake, so that in 1896 it is confidently predicted there will be an increase of 50 per cent over any previous year in the transportarion of iron ore alone, and the same conditions will make this increase a continuous one from year to year. The fixed and established work of the breakwater, together with the fact that the western arm extends absolutely to the shore, makes it impossible to increase the accommodation behind the breakwater except by extending it easterly.

The enormous growth in lake traffic has already taxed the inner harbor of Cleveland almost to its capacity, and the lake business of Cleveland demands to-day increased facilities not merely in the matter of transshipment, but in the accommodation of business actually established in the city depending upon the receiving and shipment of commodities by water, and there is no place available for the accommodation of local business of this character except east of the river.

During the past five years there have been turned away from the city of Cleveland several very important enterprises, the shipments and receipts of which by lake would be measured by hundreds of thousands of tons annually, solely for the reason that no place for the accommodation of their business could be found except upon the lake shore east of the river, and that land was unavailable by reason of the lack of protection by breakwater. And at least one institution already located there, the receipts and shipments of which would aggregate almost 2,000,000 tons in a single season of navigation, has been prevented from enlarging its facilities, and is said to have under contemplation the removal of its business because its property is unprotected and ships could not come to docks which that company desires to construct.

Concerning the statement that there is already a protected space west of the river which has thus far not been utilized, the investigation made by your committee leads them to report that this territory is available only for transfer docks—that is to say, for the receipt and transshipment of heavy freights, such as iron ore and coal. Railroad companies and others having appliances for that business in the inner harbor, which is already overtaxed, have been ready for some years to make the necessary improvements outside, and have only been deterred from doing so because of certain lamentable controversies in regard to riparian ownership; and, in consequence of the failure to develop these possibilities, Cleveland as a transferring port has suffered incalculable injury. But this business, at Cleveland's loss, has been accommodated elsewhere.

With respect to the extension to the east breakwater, the condition is essentially different. Protection is needed on that side, not for transferring docks, but for docks at which may be received and shipped commodities which enter into the local business of the port which could not under any circumstances be accommodated behind the west breakwater, and which can only be accommodated at other points at great loss, not only to Cleveland, but to the business interests of the country at large. It is an ascertained and established fact that Cleveland is the assembling point for materials in certain lines of manufacture which are dependent upon cheap water transportation for their existence. The available territory has been occupied, and the extension of these lines of business depends upon furnishing protection to our lake front as a receiving and shipping point west of the river.

While this is a matter of extreme importance to Cleveland as a city, your committee do not base their recommendation upon any advantage to local property owners, or even upon advantage to the city; but desire to report that, as a lake receiving and shipping port, Cleveland has reached a point at which enlargement is absolutely required for the accommodation of existing business, which can only be obtained by the extension of the east breakwater. There is no question that the business to be done there, which to-day would exceed half a million tons, would, within a very short time, be increased tenfold. In this connection your committee desires to submit at an early date a supplementary report showing the magnitude of the interests affected and the prospective increase in water traffic in the event of suitable protection being furnished.

As the chief center of the shipbuilding and shipowning interests of the Great Lakes, as the chief center of the iron and steel industry and lake coal traffic, the fact is that the small inner harbor of Cleveland has been outgrown, notwithstanding the expenditure during the last year of half a million dollars by the city in the improvement of the river. Great interests not located in Cleveland, but the business of which must center here or suffer great loss, depend upon adequate facilities at this port for the transaction of the commerce naturally gravitating to this city, and your committee can see no possible means of accommodating this traffic except by extending the breakwater easterly, not as a local improvement, but for the accommodation of commerce in which many cities and millions of our people have a direct and important interest.

Your committees distinctly recommend against an independent breakwater, and favor the extension of the east breakwater substantially parallel with the shore. Precisely the manner in which this should be done is an engineering question, but it should not be done, in the judgment of your committees, in any such manner as shall limit the breakwater by any means to its now projected dimensions or prevent its extension as a continuous whole a considerable distance farther east than is now provided for.

Answering specifically the five questions with which Colonel Smith's letter closes, your committees would report:

First. That there are now in operation on the lake front of Cleveland, east of Canfield street, manufacturing plants the receipts and shipments of which via lake exceed

500,000 tons, and this tonnage has to be hauled, at an average expense of 25 cents per ton, to docks in the inner harbor, this cost necessarily being added to the prices of the commodities.

Second. Answering to what extent it is certain that a further extension of the breakwater easterly would develop new enterprises, your committees would report that one company stands ready to make the necessary investment in docks and blast furnaces to yield a business at least 2,000,000 tons in each season of navigation; that one other institution has located elsewhere because of the want of protection, the business of which would equal this; another institution has, temporarily at least, located elsewhere, the business of which would be nearly as great; and that your committees are entirely within bounds in stating that the increase in business by the development or establishment of enterprises along the lake shore would furnish a lake commerce of not less than 5,000,000 tons in each season of navigation.

Third. In response to the third question asked by Colonel Smith, as to whether the benefits accruing to the United States from the extension of the breakwater would justify the investment, your committees are unqualifiedly of the opinion that one of the greatest advantages of the improvement would be the cheapening of those commodities upon which are based the manufacture of products supplied to the people of the entire country. Cleveland is probably the first city in the United States in the diversity of its manufactures, and in the manufacture of most of these articles iron and steel are the chief factors. Within a radius of 500 miles of Cleveland is gathered 48 per cent of the population of the United States, including the metropolis of the nation, and as a gateway of distribution, therefore, Cleveland holds a prominence almost unequaled by any other city in the country. That the fact is recognized that many cities are dependent upon Cleveland for iron and steel and articles made therefrom is demonstrated by the following statement made by Andrew Carnegie before this chamber on November 27, 1895:

"Cleveland is in the central zone, in which is to be made the chief part of the steel for the uses of America. Owing to the wonderful discoveries of ore and the fact that we have in the Connellsville region the cheapest body of coke-making coal—those two things uniting give this central zone supremacy."

And the further statement of Arthur J. Moxham, president of the Johnson Company, made before this chamber April 17, 1894, when, after an investigation, which had included the entire United States, to discover the economic center for the production of iron and steel, he said:

"On the eastern end of the lakes, the concentration of population, the existence of the great coking coal beds and the southern trend of the internal waterways make the theoretical point slightly southern from the extreme eastern point; in short, make that point Cleveland."

And in addition to iron and steel must be considered lumber, coal, grain, and the many other commodities in which Cleveland is already a great market and which depend upon the facilities of this port for economic distribution. The committees will gladly submit more specific information in support of these general statements if it should be desired.

Fourth. With reference to the undeveloped state of the lake front protected by the west breakwater, your committees would report that that territory is not available except for transfer docks, and that the business which should logically come to that point has been done at other places, and would emphasize that the business to be done east of the river is of a different character as to the extent that it has been accommodated at other places. It has not simply in that degree injured the city of Cleveland, but has required the business to be done less advantageously, resulting in greater cost of the products to the consumers of this country.

Fifth. Your committees do not think that an independent breakwater should be constructed, but that the present breakwater should be continued easterly, leaving to the Engineer Corps of the United States the determination of the precise manner in which this shall be accomplished.

Respectfully submitted.

HARVEY D. GOULDER,
Chairman Committee on Harbor and Docks.
CHAS. E. WHEELER,
Chairman Executive Committee, Maritime Board.

The DIRECTORS AND MEMBERS
OF THE CLEVELAND CHAMBER OF COMMERCE.

Under the reply to first question the foregoing statement shows that a benefit of $125,000 annually would be saved in cartage alone by the extension of the breakwater eastward. This sum represents interest at 4 per cent on a capital of $3,125,000.

The freights of Cleveland Harbor as reported for the six calendar years, 1894 to 1899, inclusive, are as follows:

	Tons.
1894	4,043,804
1895	5,282,599
1896	5,522,111
1897	6,118,731
1898	6,500,518
1899	7,390,921

It will be observed that the average annual increase during the time indicated has exceeded 600,000 tons.

While these amounts are necessarily incomplete and subject to error, they will show beyond reasonable question the steady and rapid increase in freights by water, so that the statements made by the committee would have even greater force as bearing upon the necessities of the harbor at the present time.

In view of the facts here presented, it is my opinion that the harbor is well worthy of such extension and other improvement as shall enable all vessels to enter in safety and find sufficient room for the rapid and economical handling of both incoming and outgoing freights.

Very respectfully, your obedient servant,

JARED A. SMITH,
Colonel, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

[Third indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
September 1, 1900.

Respectfully submitted to the Secretary of War.

This is a report upon preliminary examination of Cleveland Harbor, Ohio, with a view to further improvement (full text of item quoted within), made to comply with provisions of the emergency river and harbor act approved June 6, 1900.

It is the opinion of the local engineer "that the harbor is well worthy of such extension and other improvement as shall enable all vessels to enter in safety and find sufficient room for the rapid and economical handling of both incoming and outgoing freights."

I recommend that preparation of plan and estimate of improvement proposed be authorized; this action not to involve any expense from the appropriation made by the emergency river and harbor act of June 6, 1900.

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

[Fourth indorsement.]

WAR DEPARTMENT,
September 4, 1900.

Approved as recommended by the Chief of Engineers.

ELIHU ROOT,
Secretary of War.

PLAN AND ESTIMATE OF COST FOR IMPROVEMENT OF CLEVELAND HARBOR, OHIO.

UNITED STATES ENGINEER OFFICE,
Cleveland, Ohio, November 17, 1900.

GENERAL: In compliance with instructions in your letter dated September 15, 1900, I have the honor to submit the following report and estimate of cost of improving the harbor of Cleveland, Ohio, as indicated in my preliminary report dated August 17, 1900, and as required by the provisions of the emergency river and harbor act of June 6, 1900:

In order to ascertain as nearly as practicable "the amount of improvement that may be justified by the commerce involved," a letter was written to the president of the Chamber of Commerce of Cleveland, under date of September 7, 1900, to which a full and complete reply was returned under date of September 18, 1900.

My letter and the reply received are as follows:

UNITED STATES ENGINEER OFFICE,
Cleveland, Ohio, September 7, 1900.

DEAR SIR: The act of Congress approved June 6, 1900, "making provision for emergencies in river and harbor works for certain surveys," etc., required that a preliminary examination of Cleveland Harbor be made, "with a view to the further improvement of said harbor, first, by such additional construction or extension as may be necessary to provide a safer and better entrance for vessels at the main entrance to the breakwater in said harbor; second, to provide such additional harbor room as may be found necessary by an extension eastward of the breakwater now under construction in said harbor."

Upon the preliminary examination a report has been submitted showing that the commerce of Cleveland Harbor has been rapidly increasing during the past six years, and that the conditions are such as to justify the opinion given that the harbor is "well worthy of such extension and other improvement as shall enable all vessels to enter in safety and find sufficient room for the rapid and economical handling of both incoming and outgoing freights."

The question remaining for consideration is the length of frontage east of Muirson street, which should be protected by the breakwater extension. In this consideration the opinions of the business men of Cleveland, based upon their intimate acquaintance with the situation, present and prospective, will be of very great value. This letter is written, therefore, to ask for such information and expression of opinion on the subject as may be furnished through the courtesy of the Cleveland Chamber of Commerce.

It may not be amiss to suggest that in considering this subject the cost per lineal foot of the breakwater should be borne in mind, and that the ratio of benefit to be derived should bear some fair relation to the expenses. For this purpose it may be assumed that the breakwater will cost about $220 per foot of its length.

A reply at as early a day as may be convenient will be greatly appreciated.

Very respectfully,

JARED A. SMITH,
Colonel, Corps of Engineers.

Mr. RYERSON RITCHIE,
President of the Chamber of Commerce, Cleveland, Ohio.

THE CLEVELAND CHAMBER OF COMMERCE,
September 18, 1900.

DEAR SIR: Under date of September 7, you invited an expression from the Cleveland Chamber of Commerce, representing the business interests involved, on the two subjects of a better and more protected entrance to the present breakwater, and as to the need of an extension of the east breakwater, and how great an extension would be justified by the actual business conditions—having also some relation between the cost of the improvement and the benefits to be derived.

First. On the subject of an improved entrance to the breakwater this chamber expressed itself by the adoption of a report and resolution January 18, 1898, and September 19, 1899, copies of which are attached.

To one familiar with the development of lake transportation in recent years no argument need be added to the simple facts. The water in and outside of the entrance is approximately 22 feet deep, and a short distance inside it is maintained at a depth of 21 feet (some dredging having been done recently, as this chamber understands), both these depths being subject to some general fluctuations caused by heavy winds, which at times raise and lower the level of this part of the lake. Owing to the improvement of other channels, vessels generally, except in the lumber trade, have been loading to 18 feet draft this season, and at times even to 18½ feet. A vessel loaded so near to the full depth of the channel does not steer well in still water; and when there is even a moderate sea, such as there is day after day off this port, with the cross-current created by the send of the seas along the breakwater, the difficulty of making the entrance is manifest, as well as the danger from striking the bottom. These difficulties and attendant dangers do obtain in practice, and deeply laden vessels not infrequently have to lie off the harbor because the risk of entrance is too great, and many times in bad weather the destination of a vessel is changed from Cleveland to some other port owing to this recognized difficulty.

Considering the large commerce here and the sums already expended by the General Government in the improvement of the harbor, it is a very reasonable request that an improvement be made which will extend the entrance out into deeper water, and which will be so constructed as to better guard against cross currents. It is the more reasonable when it is considered that the plan of the present entrance was conceived with reference to an ordinary draft of not over 16 feet, by vessels less than one-half the size of those now regularly employed in transacting this commerce.

Second. The extension of the east breakwater. When, in 1897, this matter was taken up a thorough investigation was made, the results of which are stated in a recommendation dated October 16, 1897, a copy of which is attached. The three years since that report have only emphasized the reasons then set forth in favor of the extension.

The intention in that report was to deal with then fixed facts rather than in predictions as to the future, and yet from the circumstances stated then, that business enterprises desirous of locating in Cleveland were compelled to seek accommodation elsewhere—indeed, from the very nature of the subject—it was necessary to consider the then condition somewhat in the light of past development and the future prospect. All that was said by way of prediction has been most fully justified.

Cleveland has come to be the principal city of Ohio and the seventh city of the Union, by reason of its location at a point where the materials for making iron and steel assemble cheaply; where many kinds of manufacturing can be carried on advantageously and distribution can be readily made. It is for this reason that Cleveland leads all the cities of the Union in the diversity of manufactures, as is doubtless the case. The most important single element contributing to this result is cheap water transportation. For the handling of heavy, coarse freights in bulk, when the facilities of Cleveland were pretty fully taxed, there was comparatively trifling difficulty in developing a number of ports along the south shore of Lake Erie, where many millions of tons of this business has been handled and is being handled in increasing volume. But this does not offer accommodation for the increasing demand for direct contact with the water route, for the materials which are brought here and the products which are forwarded from this city. And these materials and products must be handled, because not only are the factories here, but the conditions inducing the manufacture are here in Cleveland. These conditions may not be distributed to adjacent points without destroying the advantages which Cleveland presents by its multiplicity of manufacturing facilities.

While it may be said justly that the breakwater extension for which request is made will benefit Cleveland, this is an indirect benefit which accrues to Cleveland only because the demands of trade, and the advantage to producer and consumer alike, invite the assembling of those materials at and their distribution from this point. Cleveland can expect to hold its present business and to increase that business so long as it presents advantages which are valuable to, and appreciated by, the people throughout the whole country who depend upon this market to dispose of raw materials and to buy manufactured products.

The extension of the east breakwater is required because the vessels in size and number demand greatly enlarged space here for protection against storms, and because the business of the country passing this way demands greatly enlarged space for its accommodation at this port.

The city of Cleveland within five years has expended in permanent improvements, in the inner harbor, almost one million of dollars and is now engaged on work which will increase the total cost to over $1,500,000. But practically all the space in the inner harbor is already in use. There is but one way in which the harbor of Cleveland can be enlarged, and that is by the extension of the east breakwater, affording at the same time all the advantages of a harbor for refuge and for commercial purposes.

Reference has been made in the past to the fact that the space under the west breakwater is not used to its fullest extent. The fact about this, so often reiterated, is that by reason of its location this space is available for the transfer of heavy, coarse freights—the class of business that has sought the other ports in the vicinity hereinbefore mentioned. The riparian property has been the subject of litigation between the city and various railroad companies and other parties, and it is the belief that, as soon as these controversies which are in process of settlement are disposed of, piers will be built and the property utilized for transfer purposes. This does not touch, or in the judgment of this chamber affect, the question of the extension of the east breakwater. This is quite as necessary and as practically justifiable as if there were no space behind the west breakwater.

It is unnecessary, perhaps, to state that what was suggested in 1897 has come true, in the regular output of larger and larger vessels, until the ordinary type of construction is a ship from 450 to 500 feet in length, which loads to 18 feet, and has capacity for from 6,000 to 8,000 tons of cargo.

According to the last report of the Commissioner of Navigation, the lakes built over 60 per cent of the modern steel steam tonnage constructed in the United States in the last decade. Of this, the Cleveland district built 40 per cent, or nearly 25 per cent of the construction of the whole country; and, even with the extension of shipbuilding plants over the lakes, the report states that last year the Cleveland district easily led the country with 42,119 tons, custom-house measurement. Since the commissioner's report, June 30 last, 10 such steamers have been launched, 10 are now finishing, and 20 more are under contract, making already 126,500 tons, at a cost of over $8,000,000, toward the current year. The traffic by lake, measured for convenience at Sault Ste. Marie, showing an increase in annual business of 7,500,000 tons in the five years preceding the report of 1897, has so continued to grow that the figures for this year will show an increase over 1896 of at least 12,500,000 tons. The business which is and would be transacted through this city, holding the important position it does in this relation, dependent in part, or which would be wholly dependent, on the extension of the breakwater, has increased proportionately.

With regard to the question of investment, it would seem that the foregoing general considerations are sufficient, but a striking argument is found in a feature of the report made by this chamber in 1897. It was then ascertained that from the district which is immediately contiguous to the lake shore the receipts and shipments by water, which would be handled without cartage or switching charges, exceeded 500,000 tons in the year 1896, the cartage and switching on which to the harbor averages 25 cents per ton, or $125,000 annually. There has not been time to have the figures for 1899, or for this year, worked out, but on inquiry at those manufactories where figures were obtained in 1897, it is learned that there has been an increase in substantially every instance of from 20 to 50 per cent; so that the business there now transacted, taking so narrow a view as to consider only that contiguous to the lake, would be saved quite $150,000 of expense annually.

This chamber does not ignore the fact that the extension called for involves the construction of 3½ miles of breakwater, at an approximate cost of $3,500,000. On this point it emphasizes the fact that, aside from the broader and more important general considerations, in the single item of cartage on business that can be traced to establishments immediately contiguous to the lake shore there would be a saving of more than 4 per cent on the approximate cost of the improvement. This saving is an item which now goes into the cost and therefore into the price of the commodities, and so would be saved—not to the Cleveland manufacturers, but to the people who are dependent upon this market for manufactured products.

However, this is doubtless but a small item in the aggregate of direct return to all those commodities which are dependent upon having that kind of business done cheaply, which can be done and is done at Cleveland, by reason of its situation. This is all in addition to the important consideration of a harbor of refuge accessible to the largest ships in the worst weather that obtains on this shore.

In conclusion, then, it would seem clear that the experience of the three years that have elapsed since the former report of this chamber was submitted has justified what was said then of existing conditions, has furnished proof of an astonishing addition to the business of the section affected, and has strongly emphasized the demand for this breakwater protection.

This chamber therefore feels that it is right in urging you, as it now most respectfully does, to regard carefully all the considerations and do what, as an officer, in your relation to the subject, you may properly do to encourage and further this improvement. In the judgment of the members of this chamber, the extension sought should not stop until the eastern end of the breakwater has reached the western end of Gordon Park.

Respectfully submitted.

By order of the board of directors:

F. A. Scott, *Secretary*.

Col. Jared A. Smith, *Cleveland*.

The foregoing reply by the board of directors of the chamber of commerce first refers to the necessity for an improved entrance to the harbor already protected by a breakwater. In further explanation of this point the following extract from a letter to the executive committee of the maritime board of the Cleveland Chamber of Commerce is here given:

United States Engineer Office,
Cleveland, Ohio, September 8, 1899.

Gentlemen: Replying to your letter of August 31, by Mr. F. A. Scott, secretary, I have the honor to submit the following brief explanation of the conditions at the main entrance to Cleveland Harbor, Ohio:

The width between the ends of breakwaters is 500 feet, and in this space the maximum depth is but 22.5 feet.

There is a very considerable shoaling of depths in the lake on the direct line of the channel entrance, the settlement of solid matter from the river, and perhaps by reactions of seas on the face of the breakwater, having formed a kind of ridge extending a thousand or more feet into the lake, and thus greatly decreased the depths along the line of approach to the entrance.

When heavy seas from the lake impinge upon the breakwaters they are reflected and thrown back in such a manner as to add their reflected force to that of the approaching seas, and thus make them higher and more irregular than would be the case upon the open lake.

When the seas are from westerly directions they are deflected by the breakwater and chase along its face, each wave thus being constantly increased in height and force as it proceeds, until at the entrance it has not only the effect of a high sea but a strong current is added.

In a heavy sea the keel of a vessel, especially at the bow and stern, reaches far below the depth to which it would be carried in still water. It is not difficult to conceive that a vessel drawing 20 feet might thus strike the bottom where the water when still would have depths of 25 to 30 feet, and vessels drawing 18 feet are certainly not safe in places like the entrance to Cleveland Harbor, where the depth is but 22.5 feet, and where besides the sea there is often a very strong current running obliquely across the entrance.

I believe that the entrance to Cleveland Harbor should have a clear depth of 30 feet at mean lake level, and even this depth would at times be less by 2 feet or more, because of the lowering of the lake surface. The entrance should also be devised in such a way as to eliminate the effects of seas reflected and deflected by the breakwaters.

The result desired and so much needed can doubtless be accomplished by means of short breakwaters in the lake outside of the entrance. While the expense will be considerable, it will, in my opinion, be less than the benefit to the commerce of your city and of the lakes.

* * * * * * *

Very respectfully,

Jared A. Smith,
Colonel, Corps of Engineers.

The Executive Committee of the Maritime Board
of the Cleveland Chamber of Commerce,
Cleveland, Ohio.

The foregoing explanation may be supplemented by the statement that it has long been known that the reflected seas and resultant currents in heavy storms at the entrance to Cleveland Harbor result in worse conditions than those which prevail at the same time farther out in the lake, so that an attempt to enter the harbor at such times is to invite rather than avert disaster. It has therefore happened in some cases that vessels bound for Cleveland Harbor have sought shelter on the opposite side of the lake.

With an increasing commerce by water, now exceeding 7,000,000 tons per annum, no further statements appear to be necessary to justify the improvement of the entrance for which plans and estimates of cost are now submitted.

The second point discussed by the report of the board of directors of the chamber of commerce is the extent to which it is considered necessary that the breakwater should be extended eastward. This part of the report of the committee is prefaced by a reference to the report, dated October 16, 1897, a copy of which was included in my preliminary report of August 17, 1897, to which reference has already been made.

Attention is especially invited to the letter from the chamber of commerce and to its conclusions that the harbor area protected by the breakwater should be extended eastward as far as Gordon Park.

The statements here presented seem to be sufficient without further elaboration to indicate that the immediate benefits and consequent extension of business and manufactures will be sufficient to justify the recommendation submitted.

The benefits to be derived from a harbor like that of Cleveland, extended as here proposed, are so far reaching that it may not be possible to measure them with any degree of completeness and accuracy; taking the statements as given, and it is not probable that they are in any way overdrawn, it may be safely assumed that the total of benefits to navigation, commerce, manufactures, and business interests in a large section of country will be very great, and that an estimated total benefit of $500,000 per annum will be much too small. This estimated amount would afford an annual return of 10 per centum upon an investment of $5,000,000.

In this connection, and for illustration, which may describe better than words, four photographs showing portions of the lake front of Cleveland east of the main harbor entrance are forwarded, to accompany this report.

Plate No. 1 shows the part of harbor on east side behind present east breakwater. View is taken from a point near the breakwater.

Plates 2, 3, and 4 show successive views of the lake front of Cleveland east of the present harbor. The extreme east end, as shown on No. 3, includes the west end of Gordon Park.

The photographic views do not cover the entire frontage, there being spaces not shown between each two of the plates. The spaces are, however, equally well filled with manufactories, all of which are in active operation.

To accompany this report a map has been compiled from records and surveys specially made for the purpose, covering the entire lake frontage of the present harbor, supplemented by a map of the city and lake bordering the shore eastward to Gordon Park. The locations of manufactories immediately bordering the lake are indicated upon the map.

The present project for extension of east breakwater contemplates its extension to a point in the lake nearly on the prolongation of Muirson street. The foundation for this work was completed in 1899.

The construction of breakwater is in progress under a continuous contract. The eastern limit of part completed is 432 feet eastward from the angle; the remainder will probably be completed in 1901.

From the end of the east breakwater, as heretofore planned, a line has been drawn eastward, parallel to the prolongation of lake face of east and west breakwaters. This line is approximately parallel to the shore and distant therefrom about 2,900 feet. The depth of water along this line varies, in general, from 32.5 to 35 feet, with an average depth of about 33.5 feet.

A second line nearer the shore, parallel to the first and 2,000 feet distant therefrom, will have an average distance exceeding 900 feet from the shore line, and will be located where the water is from 18 to 20 feet over nearly all the part west of Willson avenue, where the greatest necessity now exists. From Willson avenue to Gordon Park the water along this line gradually decreases to a minimum of 10 feet at the city limit.

The first of these lines is recommended for adoption as the water line on interior face of proposed breakwater. With a space of 1,700 feet between this line and the harbor line, the same as has heretofore been established in the harbor, the wharves could be extended 1,200 feet from shore to water deeper than that already mentioned for a line 2,000 feet distant. Either of these lines, or indeed some other, may in the future be adopted for a harbor line as necessities may require. In any case the room to be afforded by the proposed breakwater line is believed to be sufficient to meet all reasonable requirements.

The direction of the proposed extension to breakwater is approximately northeast, and being parallel to the shore will permit the entrance and continuation inside of seas in storms from the northeast. It is therefore necessary to devise such further protection as shall sufficiently exclude the seas, while permitting the entrance and departure of vessels, and also permitting such shore currents as arise under the action of the wind to pass through the harbor and carry away the sewage to prevent unwholesome and disagreeable conditions. For this purpose a detached section of breakwater 1,600 feet long, in addition to a pier head 60 feet square for a beacon at the outer end, has been devised, and so located as to permit an opening of 500 feet between the two points. The direction has been given with reference to fulfilling the necessary conditions at the minimum of cost, and especially with reference to avoiding an injurious concentration of the seas to break upon and injure the shore during easterly storms.

From the shore end of the line which locates the detached section of breakwater a dotted line has been extended parallel to the main breakwater as a suggestion for extension in case of injurious effects of seas from being deflected toward the shore, or in case future developments should indicate a necessity for excluding such seas as might pass inside the inner end of this part of the harbor protection. The outward deflection of east end of main breakwater is for the purpose of better protecting the entrance by deflecting the seas and of making a more convenient opening for the passage of vessels.

The improvement proposed for the present harbor entrance is shown in plan upon the map, and consists, in general terms, of two converging breakwaters, each about 1,250 feet in length, extending into the lake, one on each side of the entrance. The outer end of the west entrance breakwater is provided with a pier head 60 feet by 100 feet in plan, to serve as a site for light-house, fog signal, and dwelling. The outer end of east entrance breakwater has a pier head 60 feet square serving to protect the end of breakwater and afford a site for the beacon which will be necessary.

The west entrance breakwater is given a direction parallel with the meridian, and that on the east side is symmetrically arranged with reference to the entrance.

The opening as devised is 700 feet wide, which is 200 feet wider than the present entrance, and it is proposed to remove 200 feet from the west end of east breakwater, so that the opening between main breakwaters will also be 700 feet, and thus afford better passage to and from the wharves on east side.

The seas, which will be directed toward the angles of intersection of main breakwaters and entrance protections, will be so strong that it will be necessary to reenforce the breakwaters by covering the exterior faces below water and a short distance above with a protection which shall be triangular in section, sloping outward, with a base twice as great as the vertical. It is proposed to make these protections extend 1,000 feet from the angles on east and west sides, respectively, to make them of ordinary small stone covered with a riprap of heavy stone, and to pave the upper part from about 6 feet below to a height of 4 or 5 feet above the mean lake level.

It is proposed to construct all the pier heads of timber crib work faced with oak and filled with stone. The crib work is planned to rest at a depth of 22 feet upon a foundation of small stone protected by a riprap of heavy stone, and to be surmounted by a parapet of concrete extending from a plane 3 feet below to a plane 8 feet above the mean lake level. The area on top surrounded by the parapet of concrete will be filled with stone and paved on top.

Whether the breakwaters shall be constructed entirely of stone having a cross section essentially the same as that recently adopted for works in this district, or of a work similar to that already described for pier heads, but with a top sloping to the lake, must necessarily depend upon the cost of construction and maintenance.

For such a harbor, no provision should be made nor permitted for vessels to moor at the breakwater, because there will be ample room elsewhere. The experience in this district has been that such privileges are abused by individuals for their own benefit at a great expense to the United States for repairs, and with no possible benefit to the country at large, which has borne the expense.

In addition to the map, a tracing of a second sheet is forwarded in the same separate package. Upon this sheet are several plans and sections showing sufficiently in detail the general features of construction of the works proposed.

In the detailed estimates of cost the prices have been obtained by taking approximately the average of prices in bids recently received for construction of breakwater and piers at harbor of Lorain, Ohio.

Weights of stone in the breakwater have been computed upon a basis of certain weights per cubic foot of the entire space occupied by each class of material. While the weight of stone may be approximately uniform, the percentage of voids will be varied widely, so that the weights per cubic foot of space have been estimated with reference to the probable percentage of voids.

The estimated weights per cubic foot are as follows:

	Pounds.
Heavy paving stone	140
Material for core	120
Small stone	110
Large stone riprap	100

With the foregoing statements and explanations the following estimates of cost, omitting details, are submitted:

First. For "such additional construction or extension as may be necessary to provide a safer and better entrance for vessels at the main entrance to the breakwater."

One pierhead, 60 feet by 100 feet	$38,095
One pierhead, 60 feet square	23,541
Stone breakwater on west side, 1,250 feet long	228,424
Stone breakwater on east side, 1,250 feet long	206,015
Reenforcing front of main breakwaters, with riprap and paving	160,104
Removing 200 feet of east breakwater	6,000
Add for all contingent expenses 5 per cent	33,408
Total	695,587

Second. "To provide such additional harbor room as may be found necessary by an extension eastward of the breakwater now under construction:"

For 15,600 feet of stone breakwater at an average cost of $210 per linear foot	$3,276,000
For 1,600 feet detached breakwater at east end, at $170 per linear foot	272,000
For two pierheads, each 60 feet square	57,590
Add for all contingent expenses 5 per cent	180,279
Total	3,785,869

On the basis of constructing works of timber cribs with superstructures of concrete, supported upon foundations of small stone protected by a heavy riprap of stone along the same lines, the estimate of cost will be somewhat increased, as follows:

First. Entrance to harbor—

Two pierheads as before	$62,636
2,500 linear feet of breakwaters with protection of riprap and paving on lake face	725,000
Reenforcing main breakwaters	160,104
For removing 200 feet of east breakwater	6,000
Contingencies, of all kinds, 5 per cent	47,987
Total	1,001,727

Second. Extension of breakwater eastward—

17,200 linear feet breakwater, at $210	3,612,000
Two pierheads, 60 feet square	57,590
Add for all contingencies 5 per cent	183,479
Total	3,853,069

It is of course impossible to state definitely in advance the prices which may be obtained for such work, and it is quite possible that the type which is estimated at the lowest cost may prove the more expensive, in view of the fact that stone quarries upon Lake Erie are limited in extent and are so controlled as to practically eliminate all local competition.

The second type of work will greatly reduce the amount of stone required, and in place of the reduction use other materials which may open a broader field for competition.

The prices indicated are believed to be sufficient, provided the entire work, or at least each of the parts, may be carried on under a continuous contract.

Very respectfully, your obedient servant,

JARED A. SMITH,
Colonel, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

LETTER OF THE SECRETARY OF WAR.

WAR DEPARTMENT,
Washington, December 10, 1900.

SIR: In connection with War Department letter of 4th instant, transmitting to Congress reports of Col. Jared A. Smith, Corps of Engineers, dated August 17 and November 17, 1900, presenting plans and estimates for the improvement of Cleveland Harbor, Ohio, I have the honor to transmit herewith a further letter on the subject from the Chief of Engineers, United States Army, submitting blue-print copies[1] of two charts to accompany Colonel Smith's report, above referred to, with a view to having them printed as a part of said report.

Very respectfully,

ELIHU ROOT,
Secretary of War.

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, December 8, 1900.

SIR: Under date of November 30, 1900, I had the honor to submit to the Secretary of War copies of reports dated August 17 and November 17, 1900, by Col. Jared A. Smith, Corps of Engineers, presenting plans and estimates for the improvement of Cleveland Harbor, Ohio, prepared to comply with provisions of the emergency river and harbor act approved June 6, 1900. I now submit blue-print copies of two charts to accompany Colonel Smith's report of November 17, 1900, with the recommendation that they be transmitted to Congress with a view of having the maps printed in the Congressional document with said reports.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

Hon. ELIHU ROOT,
Secretary of War.

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[1] Not reprinted; printed in House Doc. No. 118, Fifty-sixth Congress, second session.

APPENDIX R R.

IMPROVEMENT OF ERIE HARBOR, PENNSYLVANIA, AND OF CERTAIN RIVERS AND HARBORS IN WESTERN NEW YORK.

REPORT OF MAJ. T. W. SYMONS, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1901, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Erie Harbor, Pennsylvania.
2. Harbor at Dunkirk, New York.
3. Buffalo Harbor, New York.
4. Buffalo entrance to Erie Basin and Black Rock Harbor, New York.
5. Tonawanda Harbor and Niagara River, New York.
6. Niagara River, from Tonawanda to Port Day, New York.

EXAMINATION AND SURVEY.

7. Lake Erie entrance to Black Rock Harbor and Erie Basin, New York.

HARBOR LINES.

8. Erie Basin and Black Rock Harbor, Buffalo, New York.

United States Engineer Office,
Buffalo, N. Y., July 11, 1901.

General: I have the honor to forward herewith annual reports of operations * * * on the works under my charge for the year ending June 30, 1901. * * *

Very respectfully, your obedient servant,

T. W. Symons,
Major, Corps of Engineers.

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. A.

R R 1.

IMPROVEMENT OF ERIE HARBOR, PENNSYLVANIA.

ORIGINAL CONDITION.

In its original condition the harbor of Erie was landlocked, the only entrance being to the east. The channel was narrow and tortuous, variable in position, and with a depth of only 6 feet.

PROJECT FOR IMPROVEMENT.

The project for the improvement of the harbor, as originally prepared in 1823 and approved May 26, 1824, provided for closing all of the eastern end of the harbor by means of a breakwater, in which would be left an opening 200 feet wide, and for extending to deep water in the lake two parallel piers, one on each side of the opening. This project is substantially in force at the present time, excepting that the two piers are 360 feet apart. It is understood that the project includes the necessary work of dredging to keep the channel open to the required width and depth, to make the required repairs to existing structures, and to do such work as may be found necessary for the preservation and care of Presque Isle Peninsula. This peninsula is the outer inclosure of the harbor of Erie, which is a landlocked bay, about 5 miles long, having a maximum width of 1½ miles. The peninsula is a low sand formation about 6 miles long, varying in width from 300 feet at the neck to 1½ miles at its widest part. The neck is about 2 miles long and joins the body of the peninsula to the mainland at its western end.

The preservation of the peninsula is of vital importance to Erie Harbor, and it is for the purpose of preserving the harbor that the protection of the weak parts of the peninsula has been deemed necessary. The weak portion is the long, narrow neck at the western end. The object for which all the works of protection have been constructed is the prevention of a breach through this narrow neck. The danger exists during severe storms from the westward.

At the present time there are no protection works except a few dilapidated jetties, no longer of service, one new jetty, and the main line of piles, mattresses, and stone ballast on mattresses of the shore protection constructed in 1889.

The river and harbor act of March 3, 1899, officially adopts a new and extended project for the improvement of Erie Harbor. This is in accordance with the report from this office, with map, in House Ex. Doc. No. 70, Fifty-fifth Congress, first session, and without map in the report of the Chief of Engineers for 1897, page 3238. This new project is summarized as follows:

1. To repair and keep in repair existing structures.
2. To extend the north pier 500 feet.
3. To extend the south pier 1,000 feet.
4. To dredge the entrance channel to a depth of 20 feet.
5. To dredge a portion of the eastern end of the bay, needed for access to the docks, to a depth of 20 feet.
6. To build four protection jetties along the outside of Presque Isle Peninsula.
7. To maintain existing structures and care for Presque Isle Peninsula.

The estimated cost of the project is $377,000.

ORIGINAL ESTIMATE OF COST.

The estimated cost of the original project can not well be determined, and would be of little value, as the project has been modified and changed several times, and the cost of construction and maintenance could hardly be separated. As above stated, the estimated cost of the additional work required in 1899 was $377,000.

The total amount expended by the Government on the improvement of Erie Harbor to June 30, 1900, was $1,021,271.17, and the amount expended during the fiscal year ending June 30, 1901, was $30,702.08.

No work was done under the new project previous to July 1, 1899, and the conditions were about the same as those prevailing for a number of years.

TREE PLANTING ON PENINSULA.

During 1896–1898 about 6,600 young locust and willow trees were planted on the neck of the peninsula. Most of these have grown finely and it is believed will furnish a permanent and living protection to this neck.

PRESENT CONDITION.

The work of extending the north pier has been completed, and the total length is now 3,246 feet, of which 1,234 from the inner end has been covered with a new concrete superstructure. One protection jetty has been built on the outside of Presque Isle Peninsula. The entrance channel is 300 feet wide, and 20 feet deep at mean lake level. About one-sixth of the proposed basin enlargement has been excavated to 20 feet depth at mean lake level.

On June 30, 1901, the maximum draft that could be carried into Erie Harbor was 18½ feet.

REPORT OF OPERATIONS.

At the beginning of the fiscal year a contract was in force with G. H. Breymann & Bros., of Toledo, Ohio, dated July 11, 1899, for dredging about 400,000 cubic yards, scow measure, from the entrance channel and harbor basin. No other contracts were in force nor entered into during the year.

DREDGING.

Previous to July 1, 1900, the excavation of the entrance channel had been completed and the enlargement of the harbor basin begun. There had been excavated 203,174 cubic yards of material, scow measure.

The work was continued with two large dredges and finally completed on September 21, 1900. There was excavated 236,499 cubic yards of material, scow measure, making a total excavated under the contract of 439,673 cubic yards.

The excavation in the harbor basin covered an area extending from the west line of the easternmost dock westerly 1,600 feet, and from the harbor line outwardly 750 feet.

With the exception of a small area, where rock was encountered, this excavation was carried to the full depth of 21 feet at mean lake level.

The excavation of this area gives ready access to all the docks of the Philadelphia and Erie Railroad and the Anchor Line.

The total cost of excavation under the contract was: 439,673 cubic yards, at 8¼ cents, $36,273.03.

REPAIRS TO PIERS AND BREAKWATER.

During September and October, 1900, repairs were made to 750 feet of the north pier and to the south breakwater, at a cost for materials and labor of $776.89. In view of its very decayed condition and the probability of its being thoroughly rebuilt in the near future, no repairs were made to the south pier.

WATER GAUGE.

In August, 1900, an automatic water gauge was installed on the north pier in the gauge well built in the concrete pier. This gauge has been in constant operation since September 11, 1900.

CONDITION OF STRUCTURES.

South breakwater.—This structure is from 6 feet to 12 feet wide and about 2 feet high above mean lake level. About 1,500 feet of the structure only is being maintained, the balance having been abandoned as unnecessary. The structure is very old and weak. It was repaired and put in very good condition in October, 1900, but an exceptionally severe storm on November 20 damaged it in several places. While its condition is no serious menace to the harbor, it should be thoroughly repaired or rebuilt in the near future.

South pier.—This structure, 1,220 feet long, is old and decayed, and a portion of it was nearly wrecked by the storm of November 20, 1900; but it was not thought necessary to repair it until the thorough repairs with concrete are made according to the project.

North pier.—The westerly 1,234 feet has new concrete superstructure. The next 750 feet is badly decayed, but was repaired in September, 1900, and will last for a time. This section should be repaired with concrete superstructure in the near future. The balance of the pier is in very good condition, and will need but little attention for some years.

The extreme outer end has settled about 3 feet, due to scouring of foundation. This should be more thoroughly riprapped to prevent further scouring and settlement.

Timber crib jetty.—The object of the jetty is to partly arrest the movement of sand along the north shore of the peninsula, and to protect the shore from further erosion. The present jetty is No. 2 in the projected series of four, and is situated 5,200 feet westerly from the Presque Isle light and about 4 miles from the harbor entrance. This structure has not been built long enough to thoroughly determine its effect on the shore line of the peninsula. It has stopped all erosion to the westward of it for about one-half mile and has caused the shore line to advance by accretion for about half as far, while about 500 to 1,000 feet to the eastward it has caused some erosion. The structure itself has proved amply strong for its position and purpose.

SURVEILLANCE OF PRESQUE ISLE PENINSULA.

Cutting away of the beach continued along the narrow neck of the peninsula, and many of the locust trees planted for its protection were washed out.

Watchman James Hunter was on duty throughout the year to see that no depredations were committed, and to put out fires which occasionally occur. In addition to these duties, he acted as engineer of the steam launch during the season of navigation, and since April 15, 1901, has taken charge of the water gauge.

An attempt has again been made to secure for private or corporate use a portion of Presque Isle Peninsula. At the present writing a bill is pending in the Pennsylvania legislature which proposes to give to the city of Erie certain rights in the peninsula and adjoining shallows, and to allow it to transfer these rights to others. My attention having been called to this bill, I wrote the following letter to the Chief of Engineers:

UNITED STATES ENGINEER OFFICE,
Buffalo, N. Y., March 28, 1901.

GENERAL: I have the honor to state that an effort is again being made in the interests of the city of Erie, Pa., to secure title or possession of the peninsula of Presque Isle, which forms the harbor of Erie, Pa., as shown by the inclosed copy of an act, No. 30, session of 1901, house of representatives, legislature of Pennsylvania. This act proposed to authorize the mayor and councils of the city of Erie to "improve, lease, use, or sell, at public or private sale, any or all of the land and water fronts owned by the Commonwealth of Pennsylvania located west of Erie, on Presque Isle Bay, and also on the shores of the peninsula forming the northern side of Presque Isle Bay; * * * and the proceeds arising from the leasing, using, or from the sale of said land * * * shall be used by the city of Erie in building and maintaining piers, wharves, basins, docks, slips, channels, and roads in, near, or about said Presque Isle Bay. * * *

The mayor and councils of the said city of Erie be, and they are hereby, authorized and empowered to lay out and fix the size and location of all such lots, roads, slips, docks, piers, and basins as they may deem best for the interests of said city.

So soon as the boundaries of the said land and water fronts have been determined by the mayor and councils of said city of Erie * * * a patent for said land and water fronts shall be prepared and delivered to the said city of Erie * * *.

The United States holds an incomplete title to the peninsula of Presque Isle, derived from the State of Pennsylvania. A history of this title is printed in the Annual Report of the Chief of Engineers for 1898, page 2743 et seq., together with copies of decisions by the Secretary of War on former attempts to secure possession of this peninsula.

My views in regard to the position which the United States Government should take in regard to attempts to obtain claim or possession of the peninsula are fully set forth in my letter of March 25, 1897, which views I would fully apply to the attempt outlined in the act inclosed, including the suggestion that the War Department communicate with the governor of Pennsylvania, or the legislature, advising that no action be taken which will in any way weaken the control of the peninsula by the United States Government.

I would further respectfully repeat the request that steps be taken to secure a clear and indefeasible title to the peninsula as originally presented in my letter of March 25, 1897.

Very respectfully, your obedient servant,

T. W. SYMONS,
Major, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

Under date of April 5, 1901, the Secretary of War wrote to the governor of Pennsylvania requesting that he recommend to the general assembly of the State the passage of an act confirming and vesting in the United States a complete and indefeasible title to Presque Isle Peninsula. This elicited the following reply from the governor:

EXECUTIVE CHAMBER,
Harrisburg, Pa., April 12, 1901.

SIR: Replying to your communication of the 4th instant containing a request that I favor the passage of certain legislation granting to the United States title to the peninsula lying north of Presque Isle Bay, I have the honor to inform you that after a careful consideration of all the facts in the case I do not feel justified in recommending such action to the legislature of Pennsylvania.

This peninsula is part of the triangle bought by the State of Pennsylvania from the United States and the Six Nations at a cost of nearly $200,000. It contains nearly 3,000 acres of land, which, although of little value now, may eventually become of great value. The consent of the legislature of the State of Pennsylvania for the erection of light-houses and also for the use of this peninsula for protecting Presque Isle Bay and Harbor has been granted.

You may rest assured that nothing will be done to in any way interfere with the maintenance of the peninsula as a protection to said bay, but, on the contrary, whatever action may be taken by the legislature of this State should be in the direction of aiding rather than interfering with the General Government in the maintenance of the peninsula as a defense or protection to Presque Isle Bay.

I am convinced that the best interests of the State of Pennsylvania and the city of Erie will be subserved by permitting the title to the peninsula to remain as it is.

Very truly yours,

William A. Stone.

Hon. Elihu Root,
Secretary of War.

In returning this letter of Governor Stone's to the War Department the following indorsement was made:

United States Engineer Office,
Buffalo, N. Y., April 18, 1901.

Respectfully returned to the Chief of Engineers. The inference is drawn from the last paragraph of the inclosed letter that Governor Stone is not in favor of attempts by corporations or individuals to secure possession of or claim to any of the lands on the peninsula of Presque Isle, and in so far his attitude and views seem satisfactory.

It is to be regretted, however, that the title of the United States to this peninsula can not be made complete and indefeasible, when it seems to have been the intention of the general assembly of Pennsylvania, as expressed in the act of May 11, 1871, to vest such title in the United States so that it would remain entirely under the control of the General Government.

T. W. Symons,
Major, Corps of Engineers.

It is understood that this movement to get control of the peninsula, or a large portion of it, meets with no favor among a very large portion of the people of Erie, and that a movement is on foot to prevent its being consummated if possible. (This bill has since been defeated.)

It is believed to be highly desirable that the Government title to the peninsula be cleared of all clouds or deficiencies.

PROPOSED OPERATIONS.

Further work at Erie Harbor under the present appropriations will be confined to dredging and such minor repair work as may from time to time be found necessary.

It is estimated that $150,000 can be profitably expended during the next fiscal year in carrying on the work under the project. It is proposed with this money to replace about 1,200 feet of old timber superstructure on the south pier with concrete, to build one protection jetty, to maintain existing structures and entrance channel, and to continue dredging the area at eastern end of the bay if funds will allow.

REMARKS.

The business of Erie Harbor is increasing, and this is believed to be largely due to the bettered conditions of the harbor and entrance. The further work covered by the exising project at Erie should be carried on with as little delay as practicable.

Money statement.

July 1, 1900, balance unexpended		$50,312.95
June 30, 1901, amount expended during fiscal year		30,702.08
July 1, 1901, balance unexpended		19,610.87
Amount (estimated) required for completion of existing project		252,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901:		
For works of improvement	$90,000.00	
For maintenance of improvement	60,000.00	
		150,000.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

Statement of appropriations and allotments for improving harbor at Erie, Pa., from 1823 to the present time.

1823	$150.00	March 3, 1871	$29,000.00
May 26, 1824	20,000.00	1871 allotment	10,000.00
May 25, 1826	7,000.00	June 10, 1872	15,000.00
March 2, 1827	2,000.00	June 23, 1874	20,000.00
May 19, 1828	6,223.18	March 3, 1875	80,000.00
March 3, 1829	7,390.25	August 14, 1876	40,000.00
March 2, 1831	1,700.00	June 18, 1878	25,000.00
July 3, 1832	4,500.00	March 3, 1879	25,000.00
March 2, 1833	6,000.00	June 14, 1880	25,000.00
June 28, 1834	23,045.00	March 3, 1881	20,000.00
March 3, 1835	5,000.00	August 2, 1882	20,000.00
July 2, 1836	15,122.80	July 5, 1884	50,000.00
March 3, 1837	15,000.00	August 5, 1886	37,500.00
July 7, 1838	30,000.00	August 11, 1888	83,000.00
June 11, 1844	40,000.00	September 19, 1890	40,000.00
August 30, 1852	30,000.00	1891, received from sales	4,716.89
1864 allotment	15,000.00	July 13, 1892	40,000.00
June 23, 1866	36,961.00	August 18, 1894	10,000.00
March 2, 1867	25,000.00	March 3, 1899	125,000.00
1868 allotment	40,000.00		
1869 allotment	22,275.00	Total	1,071,584.12
June 11, 1870	20,000.00		

COMMERCIAL STATISTICS OF ERIE HARBOR, PENNSYLVANIA.

Arrivals and departures of vessels for the year ending December 31, 1900.

Vessels.	Arrivals from—				Departures to—			
	Home ports.		Foreign ports.		Home ports.		Foreign ports.	
	No.	Tonnage.	No.	Tonnage.	No.	Tonnage.	No.	Tonnage.
Steam, sail, and barges..	1,272	1,694,654	82	35,852	1,285	1,651,411	70	21,895

Greatest draft of vessels, 19½ feet.
Total arrivals and departures: Number, 2,709; tonnage, 3,403,812.
Decrease of tonnage 1900 under 1899, 557,982 tons.
Value of imports, $632,253; exports, $42,173.
Enrolled tonnage 1900, 42,187 gross tons.
No new lines of transportation established.
Amount of revenue collected year 1900, lake commerce, none.

The following table, compiled from the reports of the Chief of Engineers, gives the combined number of arrivals and departures and the tonnage of arriving and departing vessels for the past ten years:

Year.	Arrivals and departures.	Tonnage.
1891	2,437	2,343,566
1892	2,180	2,409,945
1893	1,677	1,701,542
1894	2,687	3,069,545
1895	2,936	3,823,672
1896	3,100	3,634,842
1897	3,133	4,051,984
1898	2,939	3,939,019
1899	3,200	3,961,794
1900	2,709	3,408,812

Receipts and shipments by lake.

RECEIPTS.

[Tons of 2,000 pounds.]

	1895.	1896.	1897.	1898.	1899.	1900.
Merchandise	82,329	123,387	228,383	96,661	123,262	40,376
Barley	3,716	3,399	10,617	9,223	2,119	
Corn	77,276	191,621	260,290	288,400	147,831	235,940
Oats	805	6,156	5,698	5,916	2,575	
Rye	2,239	4,929	22,041	57,381	10,417	
Wheat	53,315	169,305	154,208	94,862	15,237	39,521
Flaxseed	7,837	20,092	13,335	2,224	23,475	9,622
Flour	191,811	190,720	199,798	154,614	192,324	104,757
Lumber	26,182	11,762	18,886	7,544	13,539	14,306
Laths	14,443	300	715		63	
Shingles		22	144			
Poles and stave bolts	157				520	
Ties			526			
Iron ore	907,258	925,071	1,442,756	1,221,483	1,467,204	1,670,465
Pig iron	5,783	13,810	11,085			
Copper	21,572	31,987	36,751	26,574	29,241	16,267
Lead	1,593	5,333	15,212	948	3,865	508
Limestone					26,812	
Plaster and cement	1,201	2,430	1,831		700	
Scrap iron		18,780				
Steel billets		681				
Pulp wood					14,684	40,431
Total	1,397,517	1,719,785	2,422,041	1,965,830	2,073,868	2,172,193

SHIPMENTS.

	1895.	1896.	1897.	1898.	1899.	1900.
Anthracite coal	537,628	492,563	515,801	612,282	737,719	725,101
Bituminous coal	233,489	179,640	234,432	357,870	537,600	405,741
Pig and manufactured iron				626	113	416
Merchandise	87,323	81,731	128,677	125,218	137,171	53,905
Total	858,440	753,934	878,910	1,095,996	1,412,603	1,185,163

R R 2.

IMPROVEMENT OF HARBOR AT DUNKIRK, NEW YORK.

ORIGINAL CONDITION.

The harbor at Dunkirk is naturally a simple indentation of the south shore of Lake Erie. It lies between Point Gratiot on the west and Battery Point on the east. Between the two points is a distance of about 9,600 feet, and the maximum breadth of the bay behind the line of the two headlands is 3,600 feet. The general natural depth in the bay was about 10 feet. The bay is underlaid with rock at an average depth of 15 to 16 feet. The object of the improvement is to form an artificial protected harbor in the indentation or bay above described.

PROJECT FOR IMPROVEMENT.

The original project was adopted in 1827 and, with its subsequent modifications, provided for the construction of a pier running out from the west shore of the indentation and a detached breakwater parallel with and about 2,000 feet distant from the city front. An opening between the two structures provided a harbor entrance through which a channel leading to the docks was to be deepened to 13 feet. By 1832 the sum of $28,439.84 had been expended on the original plan, and the breakwater was then 2,564 feet long and the pier 1,400 feet long. Subsequently various improvements and repairs were made. In 1848 the breakwater was demolished by storms.

In 1870 the question of improvement of this harbor was referred to a board of engineers. The board recommended a plan which provided for a detached breakwater 2,860 feet long, one part of which, 2,300 feet long, was to be nearly parallel with the shore; the other part, 560 feet long, to be nearly parallel with the axis of the channel entrance and to terminate at the position of the day beacon.

This breakwater and the pier already built were to form the harbor, and the old channel was to be enlarged to 170 feet wide and 13 feet deep.

All the works now existent at Dunkirk have been built in accordance with this plan. The project adopted by Congress and provided for by the river and harbor act of June 3, 1896, consists in completing the breakwater as before planned by the addition of 310 feet to its eastern end, adding the channel arm, 560 feet long, and in addition thereto dredging an entrance channel and harbor basin, containing in all about 65 acres, to a depth at mean lake level suitable for vessels drawing 16 feet. The estimated cost to complete this project was $408,258. It was completed at a cost of $389,060.55.

The total amount expended on the harbor to June 30, 1900, was $960,643.28.

The amount expended during the fiscal year ending June 30, 1901, was $323.49.

This amount was expended for office expenses. The harbor entrance is suited for vessels drawing 16 feet when the lake is at mean stage, and this may be stated as the maximum draft that vessels should attempt to enter the harbor with.

REMARKS.

The work outlined in the adopted project for Dunkirk Harbor has been completed and the harbor is ready for use.

Experience has demonstrated that the addition of an easterly breakwater is necessary to protect the harbor properly, and a report, with estimates of the cost of the requisite structure, was submitted and was published in House Doc. No. 74, Fifty-sixth Congress, first session.

In building the concrete superstructure of the west pier it was necessary to found part of it on old and part on new cribwork. The new cribwork settled and cracked the apron in front of the parapet, and the frosts of the winter of 1898–99 shoved the cracked-off portion lakeward. This was repaired during the season of 1899, but an examination made in May, 1900, showed that a 30-foot opening in the lake face which had been closed with concrete in bags had been washed out by the waves, carrying with it the lower walling and the timber next below. Not having been repaired in time, owing to absence of funds, this damage has increased.

A large portion of the main breakwater is old and more or less dilapidated and liable to be seriously damaged by seas, necessitating repairs, and money for these repairs should be provided. We have now on hand about $1,000 available for repairs, and it is suggested and recommended that the sum of $25,000 additional be appropriated to be used for maintenance as specified and as occasion may require.

Money statement.

July 1, 1900, balance unexpended	$1,694.10
June 30, 1901, amount expended during fiscal year	323.49
July 1, 1901, balance unexpended	1,370.61
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement, in addition to the balance unexpended July 1, 1901	25,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

Statement of appropriations and allotments for improving the harbor at Dunkirk, N. Y., from March 27, 1827, to the present time.

March 27, 1827	$3,000.00
May 19, 1828	6,000.00
March 3, 1829	9,812.75
April 23, 1830	1,342.75
March 2, 1831	7,102.50
July 3, 1832	10,200.00
June 28, 1834	4,000.00
March 3, 1835	10,988.43
July 2, 1836	11,000.00
March 3, 1837	15,000.00
July 7, 1838	10,000.00
June 11, 1844	5,000.00
August 30, 1852	30,000.00
March 2, 1867	100,000.00
1869	2,000.00
July 11, 1870	25,000.00
March 3, 1871	25,000.00
June 10, 1872	$25,000.00
March 3, 1873	48,132.95
June 23, 1874	35,000.00
March 3, 1875	35,000.00
August 14, 1876	18,000.00
1879	2,500.00
June 14, 1880	10,000.00
July 5, 1884	10,000.00
August 5, 1886	20,000.00
August 11, 1888	15,000.00
September 19, 1890	20,000.00
July 13, 1892	20,000.00
August 18, 1894	20,000.00
June 3, 1896	10,000.00
June 4, 1897	398,258.00
Total	962,337.38

COMMERCIAL STATISTICS OF DUNKIRK HARBOR, NEW YORK.

Arrivals and departures of vessels for the year ending December 31, 1900.

Vessels.	Arrivals from—				Departures to—			
	Home ports.		Foreign ports.		Home ports.		Foreign ports.	
	Number.	Tonnage.	Number.	Tonnage.	Number.	Tonnage.	Number.	Tonnage.
Steam, sail, and barges	138	52,950	1	708	139	53,658	None.	None.

Total arrivals and departures, 278; tonnage, 107,316.

Increase of tonnage, 1900 over 1899, 24,533 tons.

Amount of revenue collected for year 1900: Lake, $854.33; rail, $2,449.78.

Value of imports: Lake, $12,500; rail, $13,412.

Value of exports, none.

Two new lines of transportation established.

Receipts by lake: Lumber, shingles, and lath, 4,547 tons.

Shipments by lake, none.

Large number of excursionists enter and depart, no record.

Enrolled tonnage, port of Dunkirk, N. Y., 70 gross tons.

Greatest draft of vessels, 16 feet.

The following table gives the total of the arrivals and departures and the tonnage of the vessels arriving and departing for the past ten years, as compiled from the reports of the Chief of Engineers:

Year.	Number.	Tonnage.	Year.	Number.	Tonnage.
1891	96	24,465	1896	42	12,160
1892	58	13,756	1897	197	14,745
1893	187	19,158	1898	180	22,005
1894	76	18,763	1899	192	82,783
1895	69	15,650	1900	273	107,316

R R 3.

IMPROVEMENT OF BUFFALO HARBOR, NEW YORK.

ORIGINAL CONDITION.

Buffalo Creek was the original harbor for the port of Buffalo. In its primitive condition it was shallow and closed by a gravel bar for most of the year.

PROJECTS FOR IMPROVEMENT.

A statement as to the former projects, under which the work at Buffalo has been carried on by the General Government, is given in the Annual Report of the Chief of Engineers for 1896, page 3110.

The works built by the United States which require care and supervision are the north and south piers, protecting the entrance to Buffalo Creek and the Blackwell Ship Canal, and an outer breakwater 7,608.6 feet long, built of timber and stone. The superstructure on 3,879.13 feet of this length was replaced with concrete in 1889 and 1891, and on 1,015 feet during the present year.

There is a sand-catch pier extending out from the lake shore a distance of 1,148 feet.

The project in force for the further improvement of Buffalo Harbor is:

(1) To maintain existing structures, making the requisite minor repairs, and replacing the wooden superstructure of the breakwater with concrete when necessary.

(2) To build an extension of the breakwater from its present southern end to Stony Point, leaving the necessary openings for the convenience of commerce.

(3) To extend the sand-catch pier to the established pierhead line.

In accordance with authority contained in the river and harbor act of June 3, 1896, the work of extending the breakwater to Stony Point and the sand-catch pier to the pierhead line was advertised, and the contract was awarded to Hughes Bros. & Bangs, of Syracuse, N. Y.

Under this contract the work of dumping stone in the rubble-mound breakwater was started May 19, 1897, and of building cribs for the timber-crib breakwater July 23, 1897, and has continued ever since except during the winter. Work on the sand-catch pier was started May 25, 1897, and completed October 22, 1897.

Under the head of "Report of operations" are given the general details of the work of repair, maintenance, and new construction carried on during the fiscal year.

The total amount expended on the improvement of Buffalo Harbor to June 30, 1900, was $3,626,906.20, and the amount expended during the year ending June 30, 1901, was $382,184.46. Of this amount $292,411.61 was expended for new construction and $89,772.85 for maintenance.

GENERAL CONDITIONS.

At the end of the fiscal year the timber-crib portion of the new breakwater was nearly completed and work was progressing on the rubble-mound breakwater. At the rate at which the work is going on it is believed it will require at least two more working seasons—1901, 1902—to complete this portion of the work.

The severe storms of October 21 and November 11, 1900, wrecked the timber-crib superstructure on about 1,800 feet on the south harbor section, as described in detail in the report of operations.

A contract for replacing this with a concrete superstructure was made with the Buffalo Dredging Company April 10, 1901, and the work begun May 10, 1901. At the close of the year good progress is being made.

Work of concreting the superstructure of 1,015 feet of old breakwater was required by the terms of the contract to be completed during 1899, but it was extended to October 30, 1900, and completed on that date.

General repairs to the south pier were authorized by Department indorsement of April 3, 1900, and specifications for the necessary work were prepared and bids for the same opened May 21, 1900. All bids were ordered rejected, and the work was readvertised under date of June 20, 1900. The Buffalo Dredging Company being the lowest bidder, contract was made with them July 24, 1900, and work begun August 27, 1900. At the close of the fiscal year work is progressing rapidly.

On April 1, 1901, a contract was made with Charles A. Dennis for repairing the deck of the Stony Point section. Work was begun May 27, 1901, and at the close of the year is nearly finished.

REPORT OF OPERATIONS.

The following is a detailed report of the operations on the different works during the year and an account of the methods of construction on the rubble mound or stone breakwater and the timber-crib breakwater, together with an account of the work at the Canadian quarry located at Windmill Point, Ontario.

EXTENSION OF BREAKWATER TO STONY POINT.

This work consists of the extension of the existing Buffalo breakwater southward to Stony Point. The revised plans governing the location and construction are those given in Major Symons's modification of plan and location for breakwater at Buffalo, N. Y., dated April 6, 1896. The plans provide for the construction of a section of breakwater 10,000 feet in length, beginning at a point even with the southerly end of the old breakwater, but 250 feet lakeward therefrom, so as to leave a fair-weather entrance, and thence southerly in a straight line. The northerly 7,261 feet of the breakwater to be of approved rubble-mound type, which in its outer form is modeled upon the Delaware breakwater, and the remaining 2,739 feet, known as the south-harbor section, to be of the approved timber-crib type mounted upon an artificial foundation extending down to solid rock. Another section of timber-crib breakwater 2,826.9 feet in length is provided for, which extends out from the shore at Stony Point in a northwesterly direction, leaving an entrance 600 feet wide between the two structures. This latter section of timber-crib breakwater was fully completed on June 30, 1899, and the south-harbor section of timber-crib breakwater, with the exception of the stone riprap foundation on the lake side, on October 30, 1900.

The work is under the continuous-contract system, and is being done by Hughes Bros. & Bangs, of Syracuse, N. Y., under contracts of January 27–28, 1897, and supplemental contracts of April 26, 1898, and September 26, 1898.

RUBBLE MOUND, OR STONE, BREAKWATER.

Construction was begun on May 19, 1897, and has been in progress uninterruptedly (except during the winter months) to date. The cost of the work to date has been as follows:

For the fiscal year ending—	
June 30, 1897	$11,089.02
June 30, 1898	129,703.29
June 30, 1899	77,486.48
June 30, 1900	102,015.86
June 30, 1901	195,454.26
Total	515,748.95

For the convenience of keeping track of all operations connected with the construction of the stone breakwater the same is divided into 7 sections, 6 of which are each 1,000 feet in length, and 1 is 1,261 feet long. The northern section is No. 1, and the most southerly is No. 7. At the beginning of the fiscal year, July 1, 1900, section 1 was practically completed; section 2 about five-sixths done; section 3 about one-half done; section 4 about one-fourth done; section 5 about one-eighth done; and sections 6 and 7 not yet begun. The total expenditure at this date was $320,294.69.

The weather conditions of the first two weeks in July, 1900, were very unfavorable for work, the prevailing winds being fresh and high southwest, which caused a suspension of work on the lake face of the stone breakwater. For the remainder of the month the weather conditions were quite favorable. In order to show the effect of unfavorable seas on the progress of the work it may be stated that during the first half of the month of July but 2,425.2 tons of capping stone were set, while during the latter half 6,702.7 tons were placed, the relative percentages of work done for the two periods being respectively 26 per cent and 74 per cent.

The weather conditions for the month of August were more favorable than during July, there being fewer stormy days. Eleven thousand three hundred and thirty-nine and four-tenths tons of capping stone were placed during the month, which is the maximum for any month to date.

The month of September was a very unfavorable one for working. A severe gale occurred during the night of September 11 and morning of September 12. This storm was certainly the most severe for any September, the maximum velocity of 78 miles per hour which occurred during the night being the highest recorded at Buffalo during any September in thirty years.

At 6 o'clock p. m. on Tuesday, September 11, the water level of Lake Erie at Buffalo was 1 foot below mean lake level. At 3.30 a. m. on Wednesday, September 12, it was 5.7 feet above mean lake level. At noon of the same day it had fallen to 2.6 feet below mean lake level, a variation of 8.3 feet. The water rose again, and at 6 p. m. of the same day stood at mean lake level.

Some damage was done to the uncompleted part of the stone breakwater, a portion of the rubble hearting being washed out south of station 22 + 50 and deposited as riprap on the harbor side. Part of the capping under construction on the harbor side was disturbed between stations 21 + 60 and 24 + 20; some of the work settled 8 feet. Some of the contractor's plant went ashore. Derrick No. 17 was beached just south of the sand-catch pier, and derrick No. 15 about 1,000 feet north of the same. Dump scow H. B. & B. No. 3 was beached near the foot of Michigan street and a fuel scow about opposite the north end of the Great Northern elevator. All the small deck scows used in setting capping and revetment stone and three yawl boats also went ashore.

Wrecking operations were instituted at once by the contractors, and on September 25 derrick No. 17 was again floated. Derrick No. 15 was not floated until October 19. Owing to the above-mentioned gale and consequent disuse of plant, but a poor showing was made by the contractors for the month of September, but 5,232.5 tons of capping stone being placed during this period.

For October the weather conditions were very favorable for the first half of the month, but very unfavorable the latter half. Notwithstanding these drawbacks 9,072.1 tons of capping stone were placed during the month.

The month of November was marked by a number of severe storms. On November 5 the first winter storm with snow and rain occurred. On November 12 there was another storm, the wind blowing at the rate of 57 miles per hour from the west.

Following this storm a tremendous gale swept over Buffalo on November 21, at 1.45 p m., the wind reaching a velocity of 80 miles an hour from the west. As indicated by the United States Government gauge at the south pier, the water level of Lake Erie reached 6.4 feet above mean lake level at 4 p. m., and at midnight dropped down to —3 feet, a variation in the water level of 9.4 feet. This storm has been exceeded on only one occasion, that of January, 1890.

The contractor's plant, consisting of five derricks, was moored on the harbor side at the stone breakwater, and engaged in routine work when the storm struck it. Derrick No. 5, which was unloading rubblestone from a deck scow, broke loose from the moorings at 2.30 p. m. and went ashore about 1,000 feet south of the sand-catch pier. The deck scow, with some rubblestone aboard, struck the beach north of the derrick and gradually worked down against the sand-catch pier. Seventeen men aboard the derrick went safely ashore. One man who was on the derrick scow jumped overboard and was gallantly rescued by the captain of the life-saving crew. The remainder of the contractor's plant was with great effort towed into the shelter of the Erie Basin with the assistance of a number of the large harbor tugs.

This gale caused a settlement of the revetment and capping stone on the harbor side of the stone breakwater between stations 21+75 and 24, the maximum settlement being 5 feet. This is the same portion of the work which was settled during the gale of September 12. The damage caused by the earlier storm had only been fully repaired on November 20, the day before the gale. This gale caused the cessation of all work on the stone breakwater for the season of 1900.

The dredge *Brian Boru*, which in the beginning of the fiscal year was engaged in dredging out the rubblestone in the vicinity of the wrecked shore arm, completed this work on October 9, 1900. This dredge was generally employed at the work stated during the period mentioned, except between August 14 and September 1, when it was engaged in digging gravel in the Niagara River near Squaw Island for the hearting of the stone breakwater. The amount of gravel deposited during the months of August and September, 1900, was 23,781 cubic yards. No gravel was deposited during the other months of the second half of the season of 1900.

The total amount of rubblestone dredged from the wrecked shore arm was 76,114.625 tons, of which 65,226.525 tons were deposited in the stone breakwater, and the remainder in the Stony Point and South Harbor timber breakwaters.

As the winter of 1900–1901 was comparatively mild, the ice formation on Lake Erie was lighter than usual. This, coupled with an early spring, allowed work to be resumed on the stone breakwater for the season of 1901 somewhat earlier than usual. The contractors began driving range piles on April 9. The practice is to drive a pile on the axis of the stone breakwater at each even 1,000-foot interval. At these same points piles are driven at right angles to the axis, four on the lake side and three on the harbor side, the piles being placed 20 feet apart. They are then connected with waling made of 3 by 12 inch plank securely bolted, the range sticks being attached to these plank. The ranges have received the appellation of "fences" from the inspectors, and now go under that name. Three "fences" were built, one each at stations 40, 50, and 60.

The actual operations for the season of 1900 began on April 16, on which date some capping stone was set, and also some small rubblestone deposited. The date of beginning work for the season of 1901 was exactly one month earlier than that of 1900.

The first scow load of gravel for the season was received and deposited on May 16. This gravel is dredged from the bed of the Niagara River just off the shore of Squaw Island. The dredge first operated below the International Bridge, but it was soon moved above the bridge, where a very good quality of gravel is found. The gravel is loaded into small dump scows and towed to the work via the Black Rock Harbor, the tugboats employed being small and not able to stem the swift current of the Niagara River.

The weather conditions during the months of April, May, and June, 1901, were very good, the prevailing winds during this period being from the east, thus insuring quiet water for working. The water level for the period mentioned was also low, being generally nearly 2 feet below mean lake level.

The greatest amount of work during one month for the fiscal year was done in June, 1901, when $40,216.76 worth of work was performed. During this same month 12,201.1 tons of capping stone was placed, which is the maximum quantity to date for any one month.

The following table shows the amount of revetment and capping stone placed in the work during the fiscal year:

Month.	Working days.[a]	Total number of tons of revetment and capping stone placed.	Tons placed daily.	Number of stones placed.	Number of stones placed daily.	Average weight of stone.	Maximum weight of stone.
1900.						*Tons.*	*Tons.*
July	25	9,127.9	265.1	1,422	57	6.42	16.5
August	27	11,339.4	420	1,884	70	6.02	14.8
September	24	5,232.5	218	846	35	6.18	14.1
October	27	9,072.1	336	1,400	52	6.48	15
November	21	5,924.8	282.1	936	45	6.33	15
1901.							
April	13	1,990.1	153.1	320	25	6.22	13.7
May	26	10,727.8	412.6	1,798	69	5.91	14.6
June	25	12,201.1	488	1,903	76	6.41	16
Totals and averages.	188	65,615.2	349	10,509	56	6.24	16.5

[a] Sundays and holidays omitted.

The following is a summary of the material placed in the stone breakwater during the fiscal year ending June 30, 1901:

Rubblestone from line of Erie Canal	7,744.6 tons	
Rubblestone from wrecked United States breakwater arm	15,465 tons	
Total from the United States	23,209.6 tons, at $0.80	$18,567.68
Windmill Point, Canada:		
Original contract	54,595.6 tons, at $0.80	43,676.48
Supplemental contract	64,978.9 tons, at $0.75	48,734.18
Total from Canada	119,574.5	
Capping stone from Windmill Point, Canada:		
Original contract	None.	
Supplemental contract	65,615.2 tons, at $1.20	78,738.24
Gravel from Niagara River, New York, 44,136 cubic yards, at $0.13		5,737.68
Total		195,454.26

At the end of the fiscal year, June 30, 1901, the following material had been placed in the stone breakwater:

From the United States:	
159,229.4 tons of rubblestone, at 80 cents	$127,383.52
167,831 cubic yards of gravel, at 13 cents	21,818.03
From Canada (original contract):	
148,778 tons of rubblestone, at 80 cents	119,022.40
28,892 tons of capping stone, at $1.25	36,115.00
From Canada (supplemental contract):	
106,036.1 tons of rubblestone, at 75 cents	79,527.08
109,902.4 tons of capping stone, at $1.20	131,882.88
Total	515,748.91

A record is kept of the quantities entering into each section of 1,000 feet in length. Two of these are now completed, and from the available figures it is found that the cost of the stone breakwater will approximate $120 per linear foot.

On this basis nearly 60 per cent of the work has been done.

At the close of the fiscal year the condition of the stone breakwater was as follows:

Section 1, stations 0–10.—Completed.

Section 2, stations 10–20.—Completed.

Section 3, stations 20–30.—Completed to station 21+12. In addition, the harbor angle stones have been set for a length of 550 feet and the top lake angle stones for 200 feet. On the remainder of the section the capping stone is set to an average elevation of 10 feet above mean lake level.

Section 4, stations 30–40.—On the harbor side the capping stone is set to an average elevation of 1 foot above mean lake level for 500 feet. On the lake side the capping stone is set to an average elevation of 9 feet above mean lake level for 400 feet, to 5 feet for 300 feet, and for 300 feet to an average elevation of 4 feet below mean lake level.

Section 5, stations 40–50.—Rubblestone hearting has been placed to an elevation of 1 foot above mean lake level for 100 feet, to an elevation of 10 feet below mean lake level for 900 feet on the harbor side, and to an elevation of from 10 to 16 and 18 feet below mean lake level for 900 feet on the lake side. A corresponding quantity of gravel hearting has also been deposited in this section.

Section 6, stations 50–60.—The foundation rubblestone ridges at the foot of the lake and harbor slopes have reached an elevation of from 20 to 28 feet below mean lake level. Some little gravel has been deposited in this section.

Section 7, stations 60 to 72 + 64.—Not yet begun.

The contractors, Hughes Bros. & Bangs, have the following plant engaged in this work: 7 tugs, 5 large floating derricks capable of handling stone blocks weighing 20 tons each, 8 deck scows, 9 dump scows, used for the transportation of rubblestone, capping stone, and gravel.

There are also a number of canal boats engaged in the transportation of rubblestone from the sandstone quarries along the line of the Erie Canal in the neighborhood of Albion, Hulburton, and Holley. There is also engaged on the work an average daily force of 62 men, exclusive of tug crews and the quarry forces.

WINDMILL POINT QUARRY.

The major portion of the rubblestone and all of the revetment and capping stone used in the construction of the stone breakwater during the fiscal year came from this quarry.

At the beginning of the fiscal year, July 1, 1900, a force of 300 men and over was employed in this quarry. The contractors also had an extensive plant engaged. Among the main items might be mentioned 34 steam drills, 16 large hoisting derricks operated by steam power, 7 50-horsepower boilers, 2 locomotives, about 100 cars used for the transportation of rubble and capping stone from the quarry to the loading dock.

Owing to the gale of November 21, 1900, work at the quarry was closed down for the season somewhat earlier than usual. This storm caused considerable damage to the loading dock, tracks on the same, and also the engine houses in which the engines operating the hoisting derricks are located. Three scows which were moored to the dock were cast adrift and beached on the neighboring shore.

In the spring of 1901 extensive alterations were made in the arrangement of the incline, switching tracks, and location of derricks, which have resulted in a greatly increased output of the quarry, over 40,000 tons of stone having been quarried during the month of June, 1901.

STONY POINT SECTION, TIMBER CRIB BREAKWATER.

This breakwater, 2,802.9 feet long, consists of timber cribs filled with rubblestone and sunk with their tops to mean lake level. The superstructure is also built of timberwork filled with rubblestone, the parapet rising to 12 feet above mean lake level. The structure rests upon an artificial foundation of gravel and rubblestone. The original material underlying the site of the structure was soft clay, which was excavated to bed rock, and the resulting trench refilled with gravel to the level of the lake bottom. Upon this gravel filling was placed a course of rubblestone upon which the cribs rest. Dredging for the trench was commenced on June 29, 1897, the first crib was sunk August 26, 1897, and the whole structure was completed on June 30, 1899. The cost of the breakwater complete was $273,605.65. This breakwater withstood successfully the severe gales of December 5 and 12, 1899, and also that of September 12, 1900.

The very severe gale of November 21, 1900, however, caused some damage to the parapet, especially at the outer end. This damage consists mainly of the breaking of the upper ties, and the consequent settling of the 3-inch longitudinal decking.

In formulating plans for the repair of the damaged work it was decided to make some material changes in the construction of the parapet. These consisted in the removal of the 3-inch longitudinal decking and the substitution of a 6-inch deck laid transversely; the broken ties in the regular tiers to be raised and leveled and blocked up; the intermediate ties also to be raised and leveled and a 6 inch by 12 inch by 6 foot timber fish plate to be placed under the centers.

Two rows of stringers, 6 inches by 12 inches by 20 feet, to be laid lengthwise the work, the transverse 6-inch decking being supported by these stringers and by the parapet side walls; all work to be securely fastened by screw and drift bolts. Proper plans and specifications having been drawn up, a circular letter under date of February 5, 1901, was sent out to interested contractors, asking for proposals for doing this work. Two bids for doing this work were received, and work was let to Charles A. Dennis, the lowest bidder, and a contract entered into with him under date of April 30, 1901, the work to be completed within ninety days. The contractor began work on May 27, 1901, and at the end of the fiscal year 901 linear feet of the breakwater had been redecked.

SOUTH HARBOR SECTION, TIMBER CRIB BREAKWATER.

This breakwater, 2,739 feet long, is similar in construction to the Stony Point section, with the exception that the cribs are 180 feet long instead of 60 feet, as those of the latter. The trench excavation was begun on October 7, 1898, the trench filling November 19, 1898, and the first crib was sunk July 20, 1899.

At the beginning of the fiscal year, July 1, 1900, there was 1,682.2 linear feet of timberwork fully completed. Measured along the lake face, the length is 1,658.2 feet. The additional 24 feet of the timberwork is on account of the L at the south end, extending that distance beyond the general harbor line. The completed work at that date comprised 3 sections, each a trifle over 540 feet long, and 1 section 36 feet long. At the same date two 180-foot timber cribs were also in position and ready to receive the superstructure. By August 31, 1900, 720.3 linear feet more had been completed, being all of section 4 and 180 linear feet of section 5.

As elsewhere stated, a very severe gale occurred during the night of September 11 and the morning of September 12, 1900, following closely upon the hurricane which wrecked the city of Galveston, Tex. This gale did considerable damage to the completed work, the parapet suffering mainly, although more or less damage was also done to the middle deck. The damage consisted in the breaking of the ties, the resulting deformation of the decking, and the breaching at nine points of the upper timber walls. Some damage was also done to the work under construction on section 5, about 150 linear feet of the structure being forced 2 feet out of line.

The damaged part on this latter section was torn out at once by the contractors after the gale and repaired. The whole timber structure was completed on October 27, 1900. The portion under construction at the time of the gale was thereafter strengthened by the addition of some longitudinal timbers, blocks, and struts placed in the middle deck. Immediately after the gale mentioned, September 12, 1900, steps were taken to repair the damaged portion of the breakwater which had been accepted and paid for. A large quantity of pine lumber, 257,070 feet B. M., was procured from the Mitchell & Rowland Lumber Company, of Toledo, Ohio, which was shipped to Buffalo by rail and lake.

The needed bolts for the repair work were purchased from Weed & Co., of Buffalo, N. Y.

A floating plant, with two crews and working force, was hired from Hughes Bros. & Bangs under emergency, at a rate of $100 per working day.

The repair work was being duly prosecuted, when, on November 21, another gale occurred. This gale was of unusual violence, the wind blowing at the rate of 80 miles an hour from the west. Considerable damage was done to the superstructure of the completed work, and more especially on sections 1 and 2. On the former section nearly two crib lengths, or 360 linear feet, and on the latter section three crib lengths, or 540 linear feet, were razed almost to the water's edge. On section 3 the southern half was badly damaged, as also about two-thirds of the middle deck. About one-half of the parapet withstood the gale tolerably well, due to the additional longitudinal timbers placed there.

On section 4 the entire middle deck was razed to the banquette level. As on section 3, the parapet withstood to some extent the effect of the gale, the ties having been spaced 3 feet 4 inches centers instead of 5 feet, as usual. A longitudinal timber had also been placed here. On section 5, 150 linear feet was badly damaged, while the remaining 390 linear feet suffered comparatively little damage.

The cribs upon which the superstructure was built suffered no damage.

The timber from the wrecked work, aggregating several hundred thousand feet B. M., was washed ashore on the shore of Lake Erie between Tifft street and Stony Point.

This gale, together with the inclement stormy winter weather, caused a cessation of the repair work, which was finally closed down on December 7, 1900, on which date the floating plant, with crews and working force, hired from Hughes Bros. & Bangs was discharged. Upon the cessation of the repair work a small force of men and teams was employed in picking up such of the wrecked timber on the shore of Lake Erie as would prove to be serviceable in other work, and the same was transported and stored on the timber-framing yards of Hughes Bros. & Bangs, at Tifft farm.

The residue of the timber, too badly damaged for building purposes, was sold at public auction on January 22, 1901, to Mr. George W. Jennings for $100. Soon after the demolition of the superstructure of the South Harbor section several plans for a new superstructure were considered, and it was finally decided to rebuild the same with concrete. The necessary plans and specifications were at once prepared, and under date of January 25, 1901, proposals for building 1,800 linear feet of concrete superstructure were invited, to be opened February 25, 1901. In answer to this advertisement seven bids were received, all of which were rejected.

New bids for the work were asked for under date of March 21, 1901, to be opened April 5, 1901. On this date four bids were received, of which that of the Buffalo Dredging Company, of Buffalo, N. Y., was the lowest. The work was let to this firm on April 10, 1901, the same to be completed on or before December 1, 1901. This work is now in progress.

CONCRETE SUPERSTRUCTURE ON OLD BREAKWATER.

This work consisted in removing the old timber superstructure to 2 feet below mean lake level on the 1,015 feet of breakwater between the concreted sections, from stations 19+10 to 29+25, and replacing it with concrete. The Buffalo Dredging Company did the work, under contract dated May 31, 1899.

Work first began on June 5, 1899, as stated in the Annual Report of the Chief of Engineers for 1899, page 3105, and was completed on October 28, 1900. For a full description of methods of work and plant used, see Annual Report of the Chief of Engineers for 1900, page 4125.

At the beginning of the fiscal year, July 1, 1900, only 358.7 linear feet of the new superstructure had been completed. On the remaining 656.2 linear feet the old superstructure had been partially removed throughout the whole length; 71 concrete blocks had been set in the parapet, and the parapet walls of mass concrete had been laid on the first three sections at the north end. No decks had been laid nor any blocks set in the banquette. The work suffered no serious interruptions during the season, although high southwest winds prevailed during July and a part of August; but there was enough calm weather to permit the setting of the lake face blocks and laying of the lake walls, and the remaining blocks and mass concrete could be laid in ordinarily rough weather. Nearly all of the month of October was consumed in laying the mass concrete on the ice breaker, as this work could be done only in perfectly calm weather.

The last concrete was placed on October 25, and the last work, which consisted of fitting and placing concrete manhole covers, was done on October 28, 1900.

As stated in the last annual report, the cribs north of the ice breaker were in very bad condition, and several of them were badly broken and many timbers washed away. It was found necessary to drive 62 piles on the lake side to secure a good foundation for the blocks. For a distance of 45 feet on sections 16 and 17 the blocks on the lake side were set directly on the stone filling and riprap. The riprap here was very heavy, and was thought would furnish sufficient protection to the stone foundation. The lake side of the crib at this point seemed to be all gone. A few of the cross-ties were found in place, but most of them were drawn out several feet or gone entirely. All of the old piles found along the lake face were sawed off and used for block foundation wherever possible.

An examination of the harbor side showed that the superstructure on crib No. 18, on sections 18 and 19, overhung the crib from 4 to 6 feet. It was found that the crib projected on the lake side from 6 to 8 feet outside the face of the superstructure, and was evidently set that much out of line or some subsequent storm had shifted it. At the north end of the crib for about 15 feet the superstructure was supported on piling, but for the remaining 40 feet there was no support outside of the crib wall. A row of new oak and hickory piling was driven to rock along the face of the superstructure, and a 6 by 12 inch white-oak cap driftbolted on top and secured to the crib by ½ by 6 inch iron straps. Header blocks 4 by 5 by 10 feet were set here, the front end resting on the pile cap and the back end on the crib filling, with sufficient lap to prevent settlement in case the old floor in the overhanging superstructure should give way. For about 70 feet just south of these header blocks, on sections 17 and 18, the blocks overhung the crib face from 12 to 18 inches, and it was deemed advisable to reenforce the banquette deck here and secure the blocks to it. The deck was made about 2½ feet thicker than the plans called for and each block was secured to it by two 1½-inch square rods, which were fastened to the lifting eyes in the top of the block, and the other end, which consisted of an eye and 3-foot driftbolt through it, was molded into the mass concrete of the deck. This made the harbor face blocks and the banquette deck practically a monolith.

The piles in the old pile protection along the harbor face of the banquette were sawed off 8 inches below grade and a cap made of two pieces of 4 by 12 inch oak was driftbolted on the top. Where deemed necessary this cap was secured to the cribs with ½ by 6 inch iron straps. The crib timbers were also built up to grade behind this cap.

For about 27 feet on sections 10 and 11 on the short tangent between angles in harbor face line no crib was found near the line of piles; so the cap and piles were tied back with 1¼-inch rods to a row of old piling near the middle wall blocks. Large stone was filled in next to the piles to secure the filling, the blocks resting only on the piles and filling stone.

A very severe gale swept over the lake on the night of September 11, 1900. The wind attained a velocity of 78 miles per hour, and the water rose to 5.6 feet above mean lake level. No damage was done to the concrete in place. Several manhole covers were washed into the harbor and lost, and 500 to 600 cubic yards of crib filling stone was washed out, principally from the ice breaker. Enough stone remained, however, to complete the work. The concrete forms were badly damaged.

A severe gale on the night of October 17 washed out about 10 cubic yards of concrete from section 1 on the ice breaker (47 feet of south end) which was laid only the day before. Practically all washed out was along the lake face, and fortunately it was taken out down to the top of the blocks, so but little cutting was necessary in repairing it. The granolithic and top surfacing of the remainder of the deck was washed out from 1 to 3 inches deep. This was again finished off with a mixture of sand and cement, and at the present writing it shows no cracks or inclination to scale after weathering the winter.

It was deemed advisable to secure the manhole covers, as the storm of 1899 blew out several, and the gale of September 11, 1900, misplaced several more. A toggle of an iron bolt and an oak crosspiece was used for that purpose. An iron drift bolt was used in place of the oak piece on the banquette.

The following table gives the cost of the extra material and labor which was not included in the contract, but was found necessary to properly prepare and protect the foundation for the superstructure:

Extra materials and labor.

Building stairs and dressing off concrete	$122.50
Excavating trenches and fixing manholes	114.80
Capping old piles and driving new piles in foundation	1,221.87
1,550 feet oak piles, at 25 cents	387.50
392 feet B. M. lumber, at $35	13.72
4,139 pounds iron bolts and rods, at 6 cents	248.34
70 cubic yards riprap stone, at $2	140.00
Total	2,248.73

Total cost of the work is given below:

Removing 1,015 linear feet of old superstructure, at $6.75	6,851.25
11,780 feet B. M. of new hemlock timber, at $24 per M	282.72
9,294.5 cubic yards concrete, at $6.64	61,715.49
222 tons new stone for crib foundation, at 66 cents	146.52
Timber crib filled and complete in place	1,475.00
42 manhole covers, at $1.25	52.50
19 mooring rings, at $30	570.00
Total	71,093.48
Extra cost as given above	2,248.73
Grand total	73,342.21

CONCRETE SUPERSTRUCTURE OF SOUTH PIER.

This work consists in removing the old stone banquette for 10 feet back from its face to a depth of 2½ feet below mean lake level for its entire length of 1,400 feet, and replacing the same with concrete and covering the remainder of the old stone banquette back to the face of the parapet with a layer of concrete. The work is being done by the Buffalo Dredging Company under contract dated July 24, 1900.

Operations began on August 27, 1900, on removing the old stone banquette. The making of concrete blocks began on October 26, and the removal of the old pile protection on October 31. During the fall of 1900, 150 linear feet of old pile protection was partially removed, 1,100 cubic yards of stone was removed from the old banquette, 17 old piles were drawn, 10 new piles were driven, not cut off, and 60 concrete blocks were made. Work was abandoned for the season on November 30 on account of cold weather.

Work was resumed this spring on April 25. On June 1 no work had been done except on the pile protection. A total of 550 linear feet of the old pile cap has been removed, 425 feet of the old piles have been tested, and new piles driven, all ready to cut off to receive the steel cap. Two hundred and eighty-four new piles have been driven, all in the above stretch.

Examinations showed that very few, if any, of the old piles were long enough to reach bed rock, so most of them have been drawn and new piles driven in their place. Considerable difficulty is experienced in driving the piles in sufficiently good line to receive the steel cap, on account of the large stone and bowlders in the bottom. The original plans called for a line of sheet piling inside the other piles, but this was abandoned as not feasible on account of the character of the bottom. The regular piling is being driven as closely together as possible so as to retain the stone filling.

A circular saw is being fitted up to cut the piles off below water. This saw is attached to the pile-driver scow and is driven by the driver's engine. It is nearly ready for use and is expected to do the work very rapidly and well. As soon as this machine begins operations the derricks and mixers are all ready to follow it up and the work will be pushed until finished.

CARE OF PUBLIC PROPERTY.

The inspection steamer *Gen. John M. Wilson* was on duty throughout the year. On May 10, 1901, a new propeller was fitted to it, the old one having become broken.

OCCUPATION OF THE UNITED STATES NORTH PIER BY THE DELAWARE, LACKAWANNA AND WESTERN RAILROAD COMPANY.

This pier is the only one of the Government harbor works permanently occupied by corporations or private parties.

The occupancy was begun in 1878. A history of this occupancy and copies of official documents relating thereto are given in the Report of the Chief of Engineers for 1889, pages 2373–2383, and in the report for 1898, page 2775 et seq.

REMARKS.

The progress of the work on the breakwater extension has not been as rapid as desired by this office, or as called for by the contract obligations. At the same time it is recognized that in a work of the magnitude of this, with new and hitherto untried features, and with the necessity for procuring materials in enormous quantities, much allowance must be made for experiments for getting suitable plant, opening quarries, etc.

The close of the fiscal year 1901 finds the work progressing with great rapidity in every department. The contractors have added to their plant until it is apparently sufficient and suitable; the quarries have been opened fully and have turned out remarkably well, the stone procured from them being of excellent quality, of very large size and perfect in shape. There are sent herewith 15 photographs illustrating different features of the work.

ESTIMATES.

New construction.—On the 1st of July, 1901, the amount of funds on hand for construction of the new breakwater, after deducting indebtedness, is $660,000.

It is estimated that the contractors will earn during the fiscal year ending June 30, 1902, the sum of $480,000, and that the engineering and office expenses connected with the work will be $30,000, making a total of $510,000 to be expended for construction during the year, leaving on hand for construction July 1, 1902, $150,000.

It is further estimated that the amount which will be earned by the contractors under the continuing contract for the Buffalo breakwater extension during the fiscal year ending June 30, 1903, will be $220,000, and that the necessary engineering and office expenses will be for the same period $30,000, to which add $100,000 retained percentages which will be due, making $350,000 in all, leaving $200,000 as the amount which should be provided in the next sundry civil bill for the new work authorized by the act of June 3, 1896.

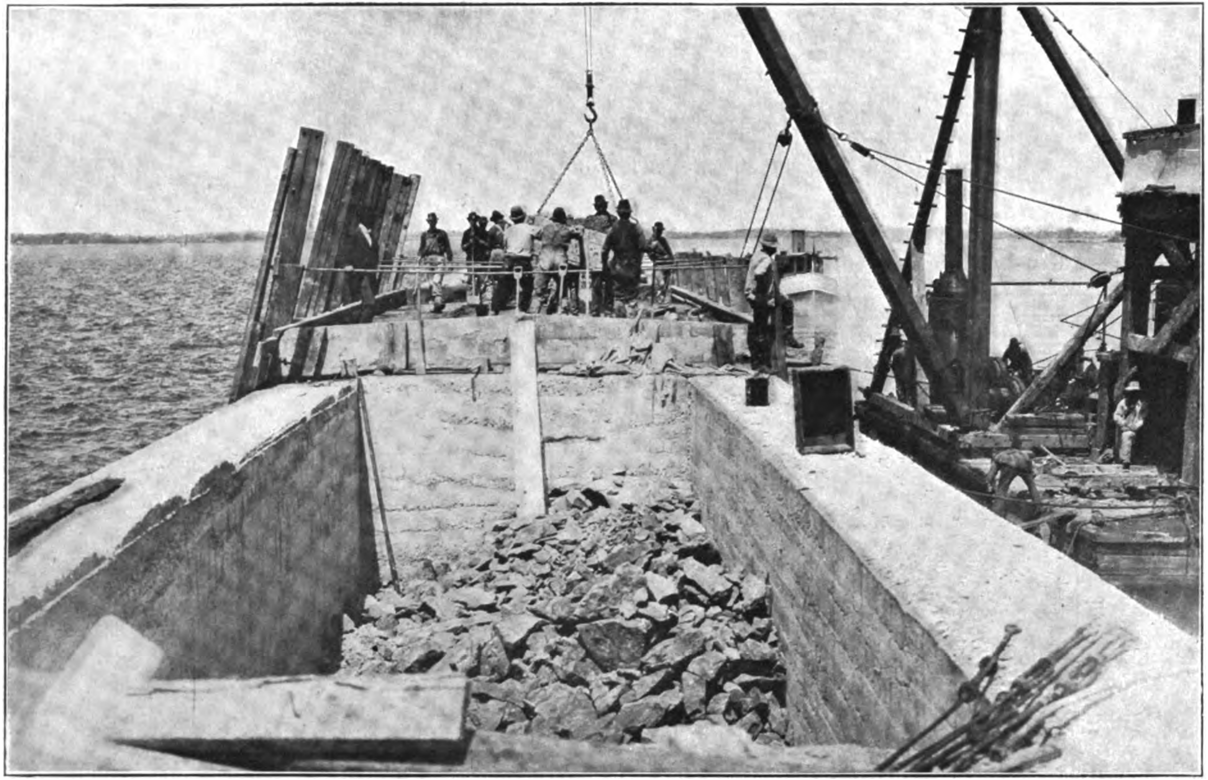
Maintenance.—On July 1, 1901, the amount of funds on hand for maintenance is $75,000. It is estimated that it will be necessary to expend for repairs to breakwater and piers during the fiscal year ending June 30, 1902, the sum of $70,000, leaving an estimated balance on hand for maintenance July 1, 1902, of $5,000.

It is estimated that during the fiscal year ending June 30, 1903, $30,000 will be required for maintenance, leaving $25,000 to be appropriated.

Money statement.

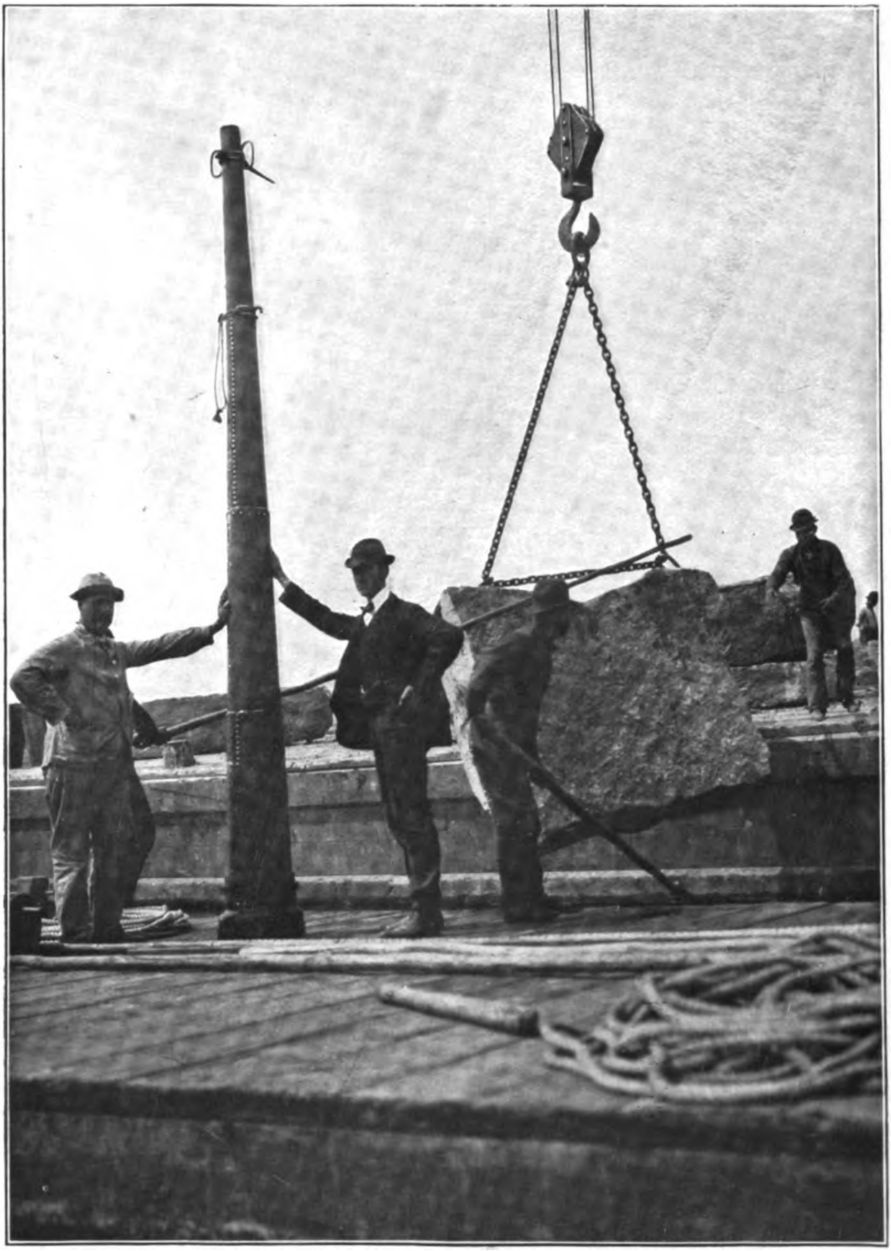
July 1, 1900, balance unexpended		$742,583.17
Amount appropriated by sundry civil act approved March 3, 1901		400,000.00
		1,142,583.17
June 30, 1901, amount expended during fiscal year		382,184.46
July 1, 1901, balance unexpended		760,398.71
July 1, 1901, amount covered by uncompleted contracts		919,528.65
Amount (estimated) required for completion of existing project		343,506.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901:		
For works of improvement	$200,000.00	
For maintenance of improvement	25,000.00	
		225,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

BUFFALO BREAKWATER CONSTRUCTION.



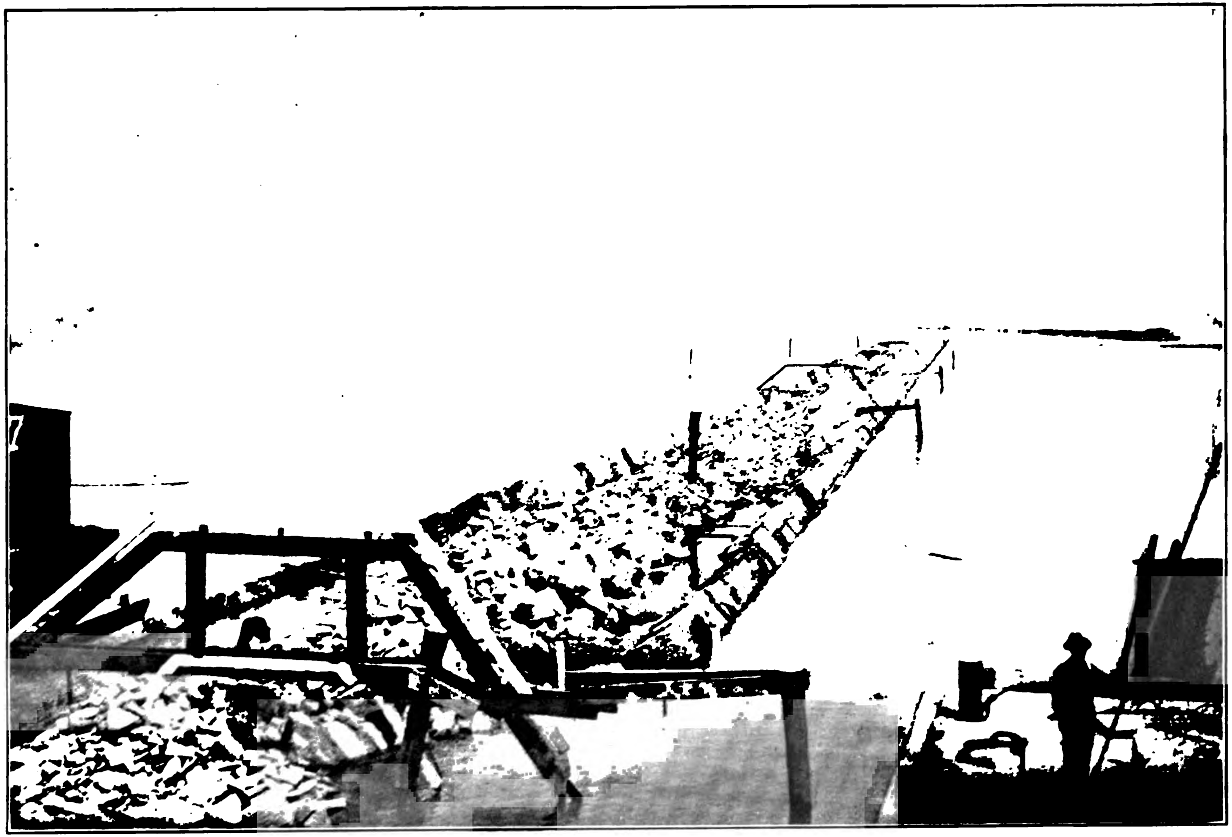
REPAIRING OLD BREAKWATER. CONCRETE SUPERSTRUCTURE, SHELL CONSTRUCTION. BUILDING PARAPET DECK.

BUFFALO BREAKWATER CONSTRUCTION.

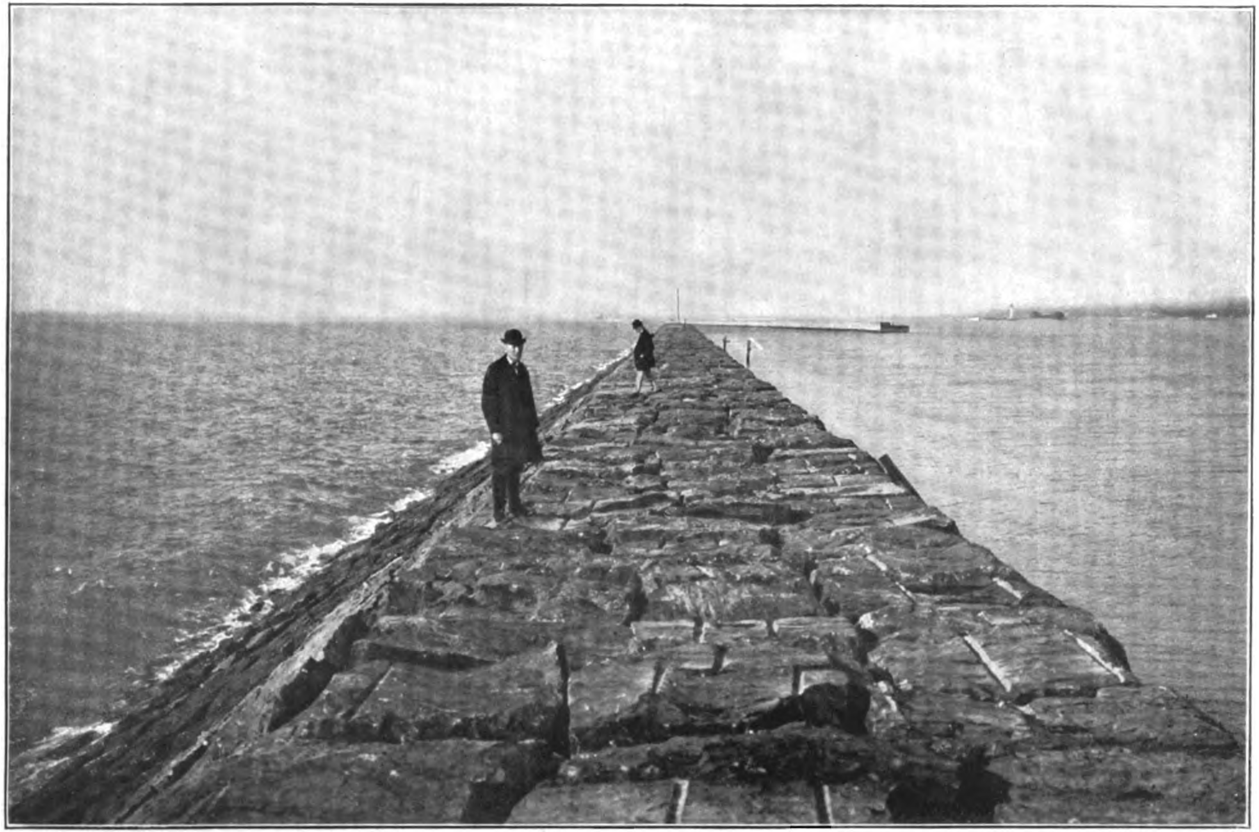


STONE BREAKWATER. WATER TELESCOPE USED IN SETTING REVETMENT STONE UNDER WATER

BUFFALO BREAKWATER CONSTRUCTION.

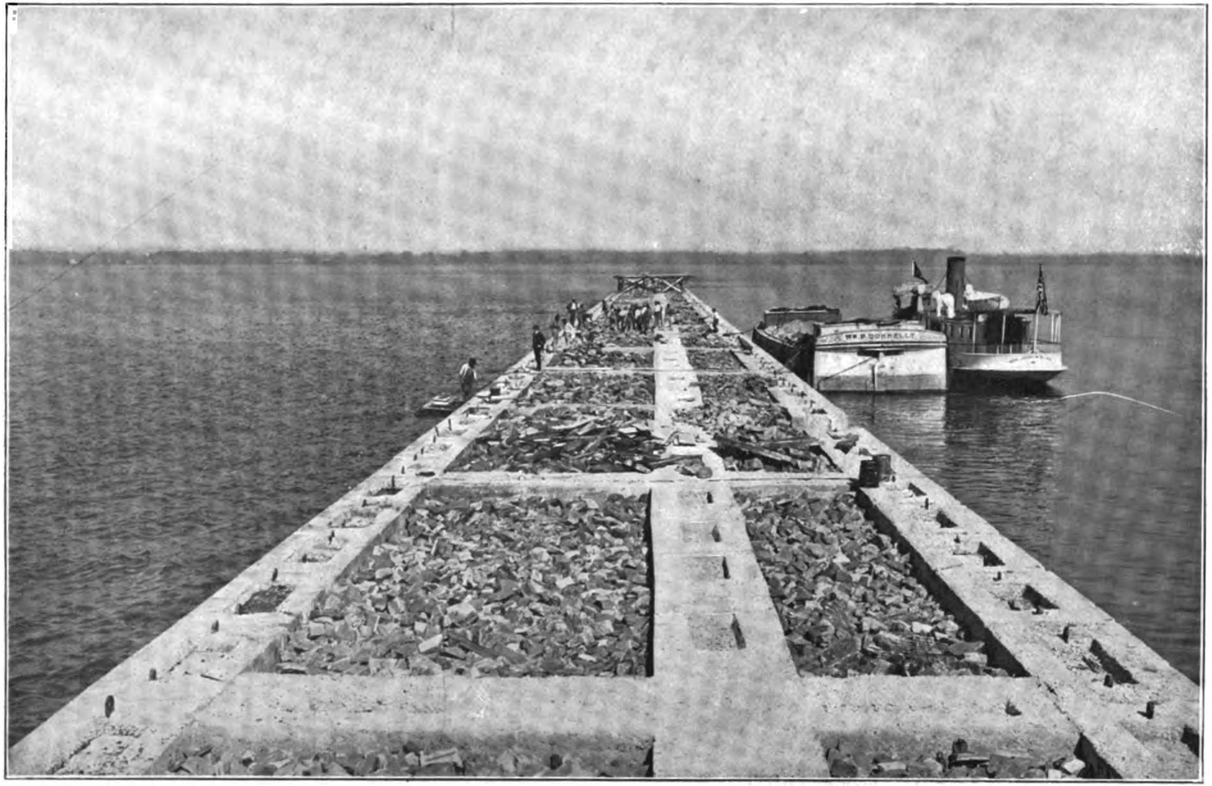


STONE BREAKWATER. GENERAL VIEW OF WORK IN STATE OF CONSTRUCTION.

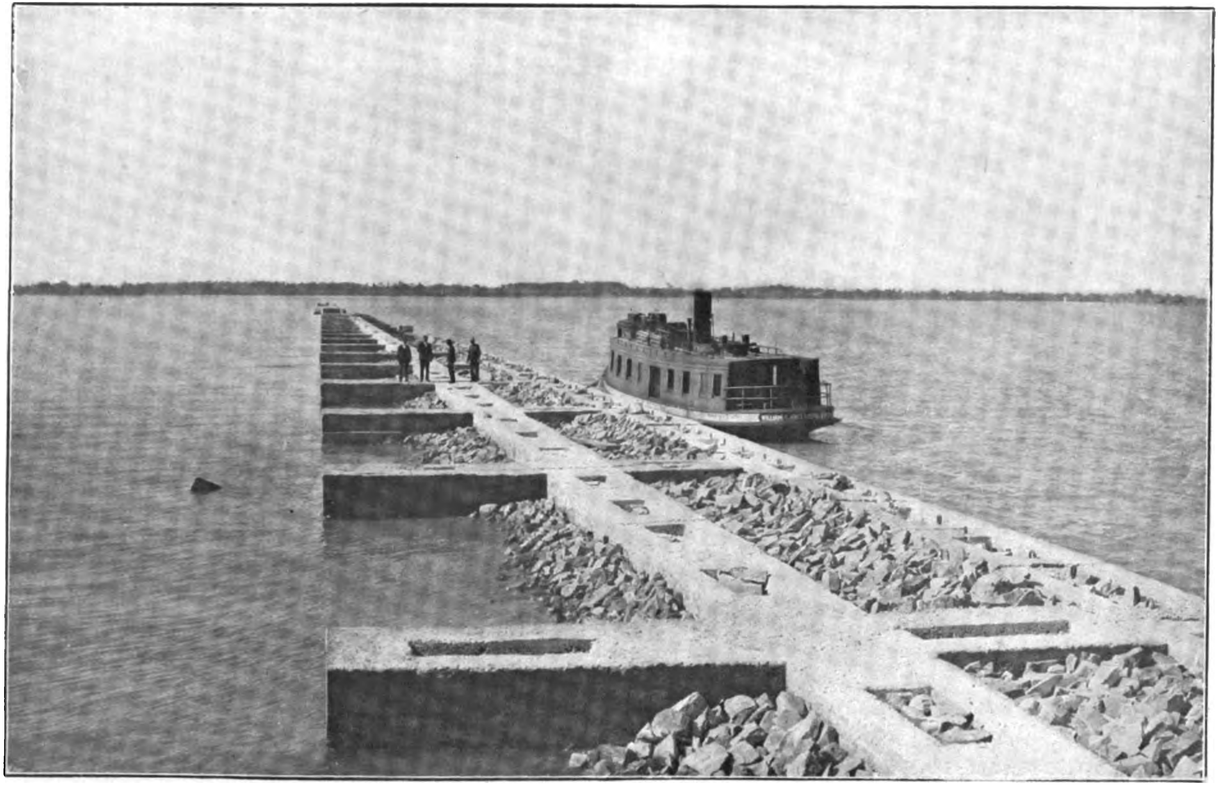


STONE BREAKWATER. GENERAL VIEW OF PORTION OF COMPLETED WORK.

BUFFALO BREAKWATER CONSTRUCTION.



NORTH BREAKWATER. SHOWING CONCRETE BLOCKS AND STATE OF WORK PREVIOUS TO GALE OF SEPTEMBER 12, 1900.



NORTH BREAKWATER. LAKE-FACE CONCRETE BLOCKS WASHED OVERBOARD BY GALE OF SEPTEMBER 12, 1900.

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Statement of allotments and appropriations made for improving harbor at Buffalo, N. Y., from May 26, 1826, to the present time.

May 26, 1826	$15,000.00	June 23, 1874	$75,000.00
May 19, 1828	34,206.00	March 3, 1875	100,000.00
April 23, 1830	15,488.00	August 4, 1877	85,000.00
March 2, 1831	12,900.00	June 18, 1878	80,000.00
July 3, 1832	10,300.00	March 3, 1879	100,000.00
March 2, 1833	31,700.00	June 14, 1880	90,000.00
June 28, 1834	20,000.00	March 3, 1881	90,000.00
July 7, 1838	68,500.00	August 2, 1882	125,000.00
June 11, 1844	40,000.00	July 5, 1884	100,000.00
August 30, 1852	14,000.00	August 5, 1886	112,500.00
March 3, 1853	349.05	August 11, 1888	225,000.00
March 2, 1855	452.32	September 19, 1890	300,000.00
June 28, 1864	15,000.00	July 13, 1892	300,000.00
July 2, 1864	37,500.00	August 18, 1894	70,000.00
June 23, 1866	131,000.00	June 4, 1897	481,250.00
March 2, 1867	100,000.00	July 1, 1898	489,746.00
April 10, 1869	89,100.00	March 3, 1899	485,498.00
July 10, 1870	80,000.00	March 3, 1899	75,000.00
March 3, 1871	100,000.00	March 3, 1901	400,000.00
June 10, 1872	75,000.00		
March 3, 1873	75,000.00	Total	4,769,489.37
February 23, 1874	20,000.00		

CONTRACTS IN FORCE.

Contract for extension of breakwater and sand-catch pier at Buffalo, N. Y.

Name and address of contractor.	Rates.								
	Rubble mound.			Timber crib.					
	Rubble stone.	Capping stone.	Gravel.	Excavation.	Gravel.	Foundation stone.	Timber cribs.	Mooring cleats.	Mooring posts.
Hughes Bros. & Bangs, Syracuse, N. Y	*Per ton.* $0.80	*Per ton.* $1.25	*Per cu. yd.* $0.13	*Per cu. yd.* $0.18	*Per cu. yd.* $0.13	*Per ton.* $0.80	*Per lin. ft.* $92.37	*Each.* $6.00	*Each.* $36.00

Name and address of contractor.	Rates.					Date of approval.	Date of commencement.	Date of expiration.
	Sand-catch pier.							
	Piles.	Waling.	Tie rods, etc.	Pile shoes.	Stone filling.			
Hughes Bros. & Bangs, Syracuse, N. Y	*Each.* $11.00	*Per lin. ft.* $0.25	*Per lb.* $0.2⅛	*Each.* $0.25	*Per cu. yd.* $1.06	1897. Feb. 19.	1897. May 19.	1902. Dec. 31.

Contract for stone delivered in Canada for breakwater at Buffalo, N. Y.

Name and address of contractor.	Rates.		Date of approval.	Date of commencement.	Date of expiration.
	Rubble stone.	Capping stone.			
Hughes Bros. & Bangs, Syracuse, N. Y.	*Per ton.* $0.60	*Per ton.* $1.00	Feb. 19, 1897	May 19, 1897	Dec. 31, 1902

Contract for stone transported from Canada for breakwater at Buffalo, N. Y.

Name and address of contractor.	Rates.		Date of approval.	Date of commencement.	Date of expiration.
	Rubble stone.	Capping stone.			
	Per ton.	*Per ton.*			
Hughes Bros. & Bangs, Syracuse, N. Y.	$0.20	$0.25	Feb. 19, 1897	May 19, 1897	Dec. 31, 1902

Supplemental contract for furnishing stone from Canada which, under original contract, was to be furnished from the United States.

Name and address of contractor.	Rates.	Date of approval.	Date of commencement.	Date of expiration.
Huhges Bros. & Bangs, Syracuse, N. Y.	5 cents per ton to be deducted from original contract price.	May 14, 1898	May 14, 1898	Dec. 31, 1902

Contract for repairing deck of breakwater, Stony Point section.

Name and address of contractor.	Rates.			Date of approval.	Date of commencement.	Date of expiration.
	Repairing deck.	New stone filling in parapet.	Repairing cross-ties.			
	Per lin. ft.	*Per ton.*	*Each.*			
Chas. A. Dennis, Buffalo, N. Y.	$1.54	$0.25	$5.00	May 9, 1901	May 27, 1901	Sept. 11, 1901

Contract for new concrete superstructure on breakwater at Buffalo, N. Y.

Name and address of contractor.	Rates.									Date of approval.	Date of commencement.	Date of expiration.
	Removing old superstructure.	New timber.	New piles.	Dredging, and placing stone.	New stone filling.	Concrete blocks.	Mass concrete.	Manhole covers.	Mooring rings.			
	Lin. ft.	*Thous. ft. b. m.*	*Lin. ft.*	*Cu. yd.*	*Ton.*	*Cu. yd.*	*Cu. yd.*	*Each.*	*Each.*			
Buffalo Dredging Company, Buffalo, N. Y.	$12.00	$100	$0.25	$1.00	$0.80	$10.00	$9.40	$5.00	$55.00	1901, April 30.	1901, May 10.	1901, Dec. 1.

Contract for new concrete superstructure on south pier at Buffalo, N. Y.

Name and address of contractor.	Rates.									
	Removing banquette.	Repairing cribs and joints.	New hemlock timber.	Removing pile protection.	Drawing old piles.	New piles driven.	Pile shoes.	Steel cap.	R. R. iron stringers.	Waling.
	Cu. yd.	*Lin. ft.*	*Thous. ft. b. m.*	*Lin. ft.*	*Each.*	*Each.*	*Each.*	*Lb.*	*Lb.*	*Lin. ft.*
The Buffalo Dredging Company, Buffalo, N. Y.	$1.75	$1.50	$60.00	$2.50	$1.50	$8.25	$2.00	$0.05½	$0.03	$0.20

Contract for new concrete superstructure on south pier at Buffalo, N. Y.—Continued.

Name and address of contractor.	Rates.							Date of approval.	Date of commencement.	Date of expiration.
	Waling clamps and supports.	Sheet piles.	Concrete blocks.	Concrete in place.	Granolithic concrete in place.	Steel clamps.	Dredging.			
	Lb.	*Each.*	*Cu. yd.*	*Cu. yd.*	*Cu. yd.*	*Lb.*	*Cu. yd.*			
The Buffalo Dredging Company, Buffalo, N. Y.	$0.05	$1.90	$7.40	$6.85	$11.00	$0.07	$0.20	1900, Aug. 10.	1900, Aug. 27.	1901, Aug. 27.

COMMERCIAL STATISTICS OF BUFFALO HARBOR, NEW YORK.

[Compiled from records furnished by collector of customs and from annual reports of the Merchants' Exchange of Buffalo, N. Y.]

Arrivals and departures of vessels for the year ending December 31, 1900.

	Arrivals from—				Departures to—			
	Home ports.		Foreign ports.		Home ports.		Foreign ports.	
	Number.	Tonnage.	Number.	Tonnage.	Number.	Tonnage.	Number.	Tonnage.
Steam	3,233	4,623,630	375	107,571	3,301	4,651,809	368	90,376
Sail and barges	512	392,893	825	217,022	549	408,304	810	209,623
Total	3,745	5,016,523	1,200	324,593	3,850	5,060,113	1,178	299,999

Total arrivals and departures:		
Vessels	9,973	
Tonnage	10,701,228	
Increase in tonnage, 1900 over 1899	220,185	
Amount of revenue collected, year ending December 31, 1900	$678,684.98	
Value of imports: *a*		
By lake	$472,443.00	
By rail	2,348,605.00	
Value of exports: *a*		$2,821,048
By lake	186,609.00	
By rail	14,412,450.00	
		14,599,059

Enrolled tonnage, port of Buffalo, 1900, gross tons, 135,999. Greatest draft of vessels, 18 feet.

Receipts by lake.

[Tons of 2,000 pounds.]

Articles.	1895.	1896.	1897.	1898.	1899.	1900.
Barley	262,997	397,565	349,126	284,334	362,608	240,835
Corn	1,089,800	1,258,184	1,498,227	1,938,697	1,528,669	1,799,128
Corn meal	2,242	19,062	40,456	7,467	7,447	6,186
Flour	870,230	1,038,418	1,244,062	1,033,536	881,010	1,082,932
Oats	355,700	641,720	1,026,250	738,170	422,790	448,114
Rye	24,405	122,343	200,380	190,878	77,906	89,385
Wheat	1,417,680	1,648,824	1,714,709	2,512,373	1,446,974	1,421,004
Flaxseed	105,770	251,190	154,542	161,128	209,523	190,271
Feed	117,880	149,134	172,344	183,054	220,476	198,209
Malt	8,551	704	67,008	11,930	8,279	4,114
Oatmeal	1,596	3,284	5,214	2,497	2,775	1,756
Pease	4,780	4,786	10,279	7,909	5,000	5,100
Oil cake	18,530	1,692	25,817	11,587	17,582	7,982
Seeds	946	7,518	7,788	8,524	12,775	8,044
Broom corn	30	1,180	1,090	875	476	60
Hops	28	50	55			

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a Includes port of Tonawanda, embraced in Buffalo Creek district.

Receipts by lake—Continued.

[Tons of 2,000 pounds.]

Articles.	1895.	1896.	1897.	1898.	1899.	1900.
Lumber	404,701	352,500	388,250	321,581	403,000	292,689
Timber	144,885	68,181	125,863		26,114	9,218
Laths	1,230	1,052	1,272	1,864	832	172
Shingles	11,110	12,479	18,248	18,859	15,884	15,295
Posts	2,701	730		104	250	125
Ties	10,049	14,965	17,147	20,775	10,000	19,275
Staves	480	778	847	3,640	1,143	2,050
Stave bolts	3,142	6,085	3,869	2,219	3,258	2,203
Copper	83,030	102,180	117,447	94,390	94,910	109,704
Copper matte	27,475	42,810				
Iron ore	500,994	443,078	609,628	811,373	1,240,179	1,361,121
Pig iron	33,122	18,935	38,101	22,486	26,797	30,308
Lead, pig	16,877	31,328	15,884	25,287	23,228	10,519
Spelter plates	6,855	10,860	6,097	4,442	14,392	8,685
Cheese	238	200	350	209		
Fish	4,742	3,935	4,153	14,812	5,073	7,204
Glucose	22,982	109,636	115,808	60,133	65,169	63,225
Hay	1,300	18,896	10,772	3,185	656	351
Lard	16,895	45,397	42,000	16,881	17,180	22,995
Pork	262	3,412	3,885	344	846	1,252
Soap	273	1,085	1,422	659	611	3,465
Starch	800	2,410	2,615	1,206	1,411	768
Wool	3,167	5,772	8,000	1,630	6,234	4,316
Cement			808			
Oil	580	11,955	2,136	654	437	144
Paper		1,470	575	279	680	22
Pelts			1,446	150	24	44
Potatoes			3,666	761	404	23
Rags and rubber	1,185	976	1,532	1,726	979	968
Raisins and canned goods		14	366			3,962
Tallow	1,222	6,523	5,441	2,817	2,185	2,653
Whisky	10	146	431	205		
Headings		716	1,745	3,220		
Total	5,581,422	6,864,108	8,062,151	8,474,765	7,161,166	7,425,876

Receipts by lake, in tons and percentages, during the calendar years 1899 and 1900.

	1899.		1900.	
	Tons.	*Per cent.*	*Tons.*	*Per cent.*
Grain, flour, malt, and seed	5,199,290	72.60	5,453,120	73.43
Lumber and timber products	460,481	6.43	336,774	4.53
Ores and metals	1,399,506	19.54	1,524,590	20.53
Miscellaneous	101,889	1.43	111,392	1.51
Total	7,161,166	100.00	7,425,876	100.00

Shipments by lake.

[Tons of 2,000 pounds.]

Articles.	1895.	1896.	1897.	1898.	1899.	1900.
Coal	2,620,768	2,400,068	2,234,329	2,455,191	2,815,165	1,826,091
Cement and plaster	78,766	94,466	115,407	212,089	214,124	472,870
Salt	100,362	94,134	112,110	109,038	82,339	82,199
Railroad iron					33,899	13,487
Sugar	192,004	211,384	224,207	238,162	269,964	395,886
Total	2,991,900	2,800,052	2,686,053	3,014,480	3,415,491	2,790,533

Shipments by lake in tons and percentages during the calendar years 1899 and 1900.

Articles.	1899.		1900.	
	Tons.	Per cent.	Tons.	Per cent.
Coal	2,815,165	82.42	1,826,091	65.44
Cement and plaster	214,124	6.27	472,870	16.95
Salt, etc	116,238	3.41	95,686	3.43
Sugar	269,964	7.90	395,886	14.18
Total	3,415,491	100	2,790,533	100

The following statistics of the canal commerce of Buffalo are also compiled from the report of the Buffalo Merchants' Exchange:

	1899.	1900.
Canal clearances	3,753	3,421
Tonnage of freight coming to Buffalo	341,736	365,725
Tonnage of freight leaving Buffalo	691,434	522,593
Number of steamers and canal boats navigating from Buffalo on the canal (about)	700	700
Average freight rate, Buffalo to New York, for wheat per bushel	$0.030	$0.025

The following gives the canal clearances for the last twelve years:

1889	6,855	1895	4,546
1890	6,429	1896	5,788
1891	6,312	1897	4,609
1892	5,460	1898	4,169
1893	7,725	1899	3,753
1894	6,621	1900	3,421

For comparison, the following statement of the last five years is given:

	Articles received by canal.		Articles sent by canal.		Flour sent.	Grain sent.
	Quantity.	Value.	Quantity.	Value.		
	Tons.		*Tons.*		*Barrels.*	*Bushels.*
1896	398,191	$35,636,664	1,172,552	$31,608,123	64,550	35,709,258
1897	377,679	37,166,685	830,285	18,402,447	15,414	2[illegible],430,601
1898	350,409	31,943,284	764,998	19,515,099	None.	23,296,458
1899	341,736	30,756,240	691,434	15,211,518	None.	21,144,762
1900	365,725	13,286,250	522,593	11,497,046	5,740	15,891,271

Assuming that the number of arrivals of canal boats equaled the number of clearances, the grand total of the commerce of Buffalo carried on by lake, river, and canal for the seasons of 1899 and 1900 is as follows:

By—	Arrivals and departures.		Receipts of freight.		Shipments of freight.	
	1899.	1900.	1899.	1900.	1899.	1900.
Lake and river	10,417	9,973	7,161,166	7,425,874	3,415,491	2,790,533
Canal	7,506	6,842	341,736	365,725	691,434	522,593
Total	17,923	16,815	7,502,902	7,791,601	4,106,925	3,313,126

Total receipts and shipments, 1899, 11,609,827 tons; 1900, 11,104,727 tons. The amount of wheat and breadstuffs going east by canal in 1895 was the lowest for many years, and the canal freights were the lowest ever known, the average rate, Buffalo to New York, for wheat and corn having been only 2.2 cents.

The business on the canal picked up during 1896, but it has gradually decreased since to nearly the amounts of freight and rates of carriage reached in 1895.

R R 4.

IMPROVEMENT OF BUFFALO ENTRANCE TO ERIE BASIN AND BLACK ROCK HARBOR, NEW YORK.

The first appropriation for this work was made in the river and harbor act of March 3, 1899.

The language of the law referring to this item is as follows:

> For improvement of the Buffalo entrance to Erie Basin and Black Rock Harbor, New York, fifty thousand dollars: *Provided*, That a contract or contracts may be entered into by the Secretary of War for such materials and work as may be necessary for the completion of said project, in accordance with the recommendation of the Secretary of War, House Document Numbered Seventy-two, Fifty-fifth Congress, first session, to be paid for as appropriations may from time to time be made by law, not to exceed in the aggregate one hundred and ninety-eight thousand one hundred and thirteen dollars and eighty cents, exclusive of the amount herein appropriated.

A full description of the locality and a discussion of the project for the work is printed, with map, in House Document No. 72, Fifty-fifth Congress, first session, and in the Report of the Chief of Engineers for 1897, pages 3246 et seq.

PROJECT FOR IMPROVEMENT.

Briefly stated, the project for improvement is to build a breakwater 2,200 feet long, covering and protecting the entrance to Erie Basin and Black Rock Harbor and the lake front of Buffalo Harbor, between the New York State structures known as the Erie Basin breakwater and the Bird Island pier.

The amount expended on this project up to June 30, 1900, was $96,152.54. At this time nearly all the cribs were sunk in place ready for the superstructure.

The amount expended during the fiscal year ending June 30, 1901, was $140,125.56. The result has been the completion of the breakwater called for by the project, at a total cost of $236,278.10, including office and engineering expenses.

HISTORY OF ERIE BASIN.

As early as 1839 the State engineer reported the necessity of increasing the harbor facilities at Buffalo, and recommended the construction of basins and slips.[1] Nothing definite was done, however, until 1847, when in June of that year the common council of the city of Buffalo invited the canal board to visit the city and see for themselves the cramped and crowded condition of the harbor and the need for enlargement.[2]

Late in July of that year eight of the canal board and the chief and division engineers complied with this invitation, and shortly after made the following recommendations to the legislature:

First, to complete the Hamburg Canal; second, to excavate a basin and slip in the vicinity of Dead Creek, connecting the Hamburg Canal with the Buffalo Creek (now known as Ohio Basin and slip); third, to connect the Erie Canal with Buffalo Creek near its mouth by a ship canal, said canal to be one-half mile long, 300 feet wide, and of sufficient depth to accommodate lake vessels, and to be connected with the Erie Canal by three slips (see tracing of "Map by P. Emslie, surveyor, showing proposed improvements in 1847"). The original plan as shown on this map was to extend the ship canal to the entrance to Black Rock Harbor, while the plan proposed by the canal commissioners contemplated extending the canal only half a mile from Buffalo Creek, which would take it to the west line of slip No. 3, as shown on the map.

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[1] Assembly Documents, No. 363, 1839.

[2] Canal Commissioners' Report, 1847, p. 64.

An appropriation of $150,000 was made by the legislature in 1847 to carry out the suggestions of the canal board as outlined above.[1]

The land needed for the basins, slips, etc., was to be furnished the State by this city, free of charge. This land was taken by condemnation proceedings, pursuant to a provision of the city charter, which proceedings were begun in September, 1847, and completed on May 6, 1848. The total cost of the land conveyed in the first deed was over $60,000.[2] On May 18, 1848, a deed was executed from the city of Buffalo to the State of New York, conveying the land for the Erie Basin and slips as proposed in 1847.[3]

Subsequent to this the plans for Erie Basin were materially changed, enlarging it by moving the southerly line out to about the shore line of 1816, including all the land between the first grant and the lake. To furnish the land for this enlarged plan the city executed another deed to the State on August 20, 1849, conveying the land described in the deed as follows:

Commencing on the westerly line of outer lot No. 151, 30 feet northerly from the south line of the north pier, so called, of Buffalo Harbor; thence on a curve, the radius of which is 1,000 feet, easterly to a point on the easterly line of Water street extended, 82½ feet westerly from the northerly line of Erie street, measured on the easterly line of said Water street; thence northerly on a curve, the radius of which is 1,200 feet, to a point on the northerly line of outer lot No. 6, 726 feet westerly from the westerly line of land appropriated by the State of New York for the enlargement of the Erie Canal, as now in progress of being enlarged, to be measured on said northerly line of lots No. 6 and No. 5; thence north 13 degrees west 300 feet; thence north 18 degress west 300 feet; thence north 23 degrees west 300 feet; thence north 28 degrees west 300 feet; thence north 33 degrees west 532 feet to the northerly line of Hospital (Wilkeson) street, 390 feet from the Erie Canal; thence north 56½ degrees east on the north line of Hospital street, 390 feet to the westerly line of land appropriated by the State of New York for the enlargement of the Erie Canal; thence northerly on the westerly line of said canal 100 feet; thence southerly and parallel to Hospital street 1,200 feet to the west line of lot No. 14 of the State of New York, survey of the south village of Black Rock, being the shore line of Lake Erie; thence southerly and along the shore line of Lake Erie to the west line of outer lot No. 151 of the Holland Land Company's survey of outer lots in the village of Buffalo; thence southerly on the west line of said outer lot No. 151 to the place of beginning.[4]

Also all that other piece of land described as follows: Beginning at a point in the westerly line of the Erie Canal 156 feet southerly from the intersection of the westerly line of the canal with the southerly line of Genesee street; thence at right angles with the Erie Canal westerly to the easterly line of outer lots Nos. 12 and 14; thence westerly on a line parallel to Genesee street to the easterly line of the Erie Basin, hereinbefore described; thence southerly on the easterly line of Erie Basin 101 feet; thence north 61½ degrees east and parallel to Genesee street to the dividing line between outer lots Nos. 11 and 12; thence at right angles with the Erie Canal easterly to said canal; thence north 35½ degrees west to place of beginning.

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[1] Canal Commissioners' Report, 1847, p. 59.

[2] Common Council Proceedings. See Erie Basin in Index to Streets.

[3] Erie County clerk's office. Deeds, liber 96, p. 371. See tracing map, Buffalo and Black Rock Harbor. Improvements proposed in 1847. P. Emslie.

[4] Erie County clerk's office. Deeds, liber 49, p. 635. See tracing Erie Basin and slips. Land conveyed by deed shaded yellow.

Also all that other piece of land described as follows: Beginning at a point in the westerly line of the Erie Canal 50.38 feet northerly from the line between outer lots Nos. 7 and 5; thence south 61¾ degrees west and parallel to the line between said lots 7 and 5 and 6 and 8 to said Erie Basin; thence southerly on the easterly line of said basin to a point which shall be 50 feet in the nearest direct line southerly from the line between said outer lots 6 and 8; thence north 61¾ degrees east and parallel to said lot lines and 50 feet distant therefrom to the Erie Canal; thence north 35½ degrees west along said canal 100¾ feet to the place of beginning, be the same more or less.

Signed by the mayor of Buffalo.

The original plans of the basin were made in 1849, were changed in 1851 by increasing the amount of piling and loose stone in the breakwater and cribbing the sides of the slip, and were changed again in 1855 by increasing the length of the breakwater 200 feet and constructing a jetty pier at the north end, protecting the entrance to slip No. 3.[1]

The construction of the Erie Basin was first contracted for in February, 1850. This contract was declared abandoned in December, 1857, as it was not prosecuted according to the terms stated in the contract. The work was again contracted for on March 4, 1858, and finished in 1862.[2]

The State did not use all of the land deeded to it by the city for the Erie Basin, so in 1864 the common council of the city of Buffalo petitioned the canal board to abandon the land not used, which said board did on December 29, 1864. The city immediately began proceedings to have the title revested in the original or previous owners thereof, which was accomplished on February 6, 1865.[3]

HISTORY OF BLACK ROCK HARBOR.

About the year 1807 a pier was sunk in the bay or eddy below Bird Island and warehouses were erected. This was the first step toward harbor improvements in either Buffalo or Black Rock, and was done by a private corporation, Porter, Barton & Co., a large forwarding or freight company, who did nearly or quite all of that business in western New York at that date. Gen. Peter B. Porter was one of the principal members of the firm. In 1815 the same company built a large warehouse on the mainland at Black Rock, nearly opposite where the Queen City Mills now stand, or just below Ferry street.[4]

No work of any consequence was done on the Black Rock Harbor, however, until 1822, when the "Experiment pier" was constructed in the most exposed part of the Niagara River, probably about opposite the present waterworks intake crib, and in 1823–1825, when the pier was completed from Bird to Squaw islands and the embankment on Squaw Island and the dam from thence to the mainland were built.[5]

The principal consideration in the early study of the location of the harbor at Black Rock and Buffalo, or rather at Black Rock or Buffalo, was its convenience and stability for the western terminus of the Erie Canal. The controversy between the two places waxed very warm, and for a short time Black Rock seemed to be the victor. General Porter was the great champion of Black Rock's interests, while Judge Wilkeson and the powerful influence of the Holland Land Company looked after those of Buffalo. The victory of Black Rock was short lived, for the frequent breaks in the Black Rock pier blasted the hopes of its ever becoming a great harbor.

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[1] State Engineer's Report, 1856, p. 143.

[2] Canal Commissioners' Report, 1860, p. 87; 1850, p. 61. See tracing map Erie Basin and slips in Canal Commissioners' Report for 1861; also same for plans and cross sections of breakwater and pier.

[3] Common Council Proceedings, 1865, p. 47.

[4] Buffalo Historical Society Publications, Vol. II, p. 17; also Vol. I, p. 164; also manuscript in Buffalo Historcal Society library by Richard Williams, 1865 (see note 1).

[5] Buffalo Historical Society Publications, Vol. I, p. 153; Canal Laws 1825, Vol. II, appendix.

There were several different plans proposed for a harbor at Black Rock early in the nineteenth century. One of the earliest and by far the most extensive plan was to construct a pier from Bird Island to Squaw Island, from thence to Strawberry Island, and thence to the head of Grand Island, and throw a dam across the east branch of the Niagara River at White Oak Bluffs, a short distance below Tonawanda. This would have diverted nearly if not quite all of the waters of the river down the Canadian channel, and probably would have caused international difficulties, which, with its great cost, caused the early abandonment of the idea.[1]

Another plan, similar to the one finally adopted, was to connect Bird and Squaw islands with a pier which was to be about 30 rods from shore, throw up an embankment along the east shore of Squaw Island, and construct a dam across to the mainland near the lower end of the island. The only change from this in the plan finally adopted was that the pier was built nearer in to shore. This plan originated with James Geddes, State engineer, and one of the principal engineers on the Erie Canal during its construction.[2]

A little different plan from the above was proposed by some of the citizens of Black Rock, and was to turn the pier at right angles with the shore about 50 rods below Bird Island, extending it about two-thirds of the way across the east channel to about 9 feet of water; thence again at right angles downstream to connect with the head of Squaw Island. The embankment and dam were to be the same as in the other plan. Six large waste gates were to be provided to take care of the surplus water. The advantage urged in favor of the scheme was a large area of good water in the harbor, about 25 or 30 acres, with from 16 to 18 feet of water. Its great obstruction to the flow of the river prevented its serious consideration.[3]

It is interesting to note the change which the construction of the pier from Bird Island must have made in the character of the river. In a letter from James Geddes, State engineer, dated February 27, 1822, to James L. Barton, postmaster at Black Rock, he says that he is persuaded that but very little more than half the waters of the Niagara pass down the British side of Bird Island.[4] In a report of the canal commissioners dated March 20, 1824, in speaking of the relative quantity of water passing out of Lake Erie between Bird Island and the two shores, they say: "We judged that about five times as much passed on the Canada side as passed on our side." The latter note is probably much nearer the truth, since it was made after an examination of the river at this point by some of the commissioners, while the former was evidently only an opinion expressed from a cursory observation. Whichever way we take it, the change must have been very great, for now, with the pier removed, probably not one-hundredth part would flow down the east side of the island.[1]

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[1] Buffalo Historical Society. Paper by Richard Williams, January 16, 1865; manuscript in Buffalo Historical Society library.

[2] Canal Laws, N. Y., 825, Vol. II, p. 526; also see tracing of map, A Part of Niagara River, Showing General Porter's Proposed Harbor."

[3] Black Rock *v.* Buffalo; Black Rock, 1822. Pamphlet by General Porter and associates.

[4] Buffalo Historical Society. Paper by R. Williams, 1865.

The first harbors at Buffalo and Black Rock were constructed at the expense of the State as a terminal for the Erie Canal. At that time Buffalo and Black Rock were two separate and rival villages, and each exerted itself to procure the termination of the canal in its harbor. Until 1822 the majority reports of the board of canal commissioners, and also the State engineers, were in favor of Buffalo Creek as the terminal of the canal. The principal arguments urged in its favor were the higher level from which to take the water to supply the western reach of the canal, and the absolute security of this harbor from the storms and ice of Lake Erie and Niagara River, insuring less interruptions to canal traffic.[2] There were nearly always minority reports in favor of Black Rock, and James Geddes, one of the principal canal engineers, always favored this harbor in preference to Buffalo. The principal points urged in favor of Black Rock Harbor were that it shortened the canal about 2 miles; that it was considerably larger; it was easier to enter in a storm (by descending the river and entering harbor through ship lock below); would enable State to sell land in the mile strip at an enhanced value, and would offer hydraulic power that State could sell. The citizens of Black Rock also proposed to build this harbor for what the independent canal to Buffalo would cost, thereby making it a cheaper harbor for the State.[3]

On April 17, 1822, an act entitled "An act to authorize and encourage the construction of harbors at Buffalo Creek and Black Rock," passed the State legislature, and authorized the payment of not to exceed $12,000 for the completion of improvements at the mouth of Buffalo Creek to allow the passage of vessels of 8-foot draft at all seasons of the year. This money was to be paid after the successful completion of the project. The act also carried a similar amount for Black Rock, under similar conditions. This was the first appropriation made by the State for either harbor.[4]

At a meeting of the canal commissioners in June, 1822, it was decided to advise Gen. P. B. Porter and associates that if they succeeded, in a fair experiment, by constructing 10 or more rods of the pier on the plans proposed by them (Porter, etc.), in the most exposed part of the river by May or June next, to the satisfaction of the commissioners, and if it stood the test of the winter's ice and spring floods they would contract with them for the completion of the plan. During the summer of 1822 about 16 rods of this pier was built at the point proposed, and it successfully withstood the breaking up of the ice, which was especially bad that spring.[5]

In June, 1823, the commissioners decided to construct the Black

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[1] Canal Laws, N. Y., 1825, Vol. II, p. 534.

[2] Canal Laws, N. Y., 1825, Vol. II. Appendix contains reports. Also Buffalo Historical Society. Paper by R. Williams, 1865.

[3] Canal Laws, N. Y., 1825, appendix.

[4] Canal Laws, N. Y., 1825, Vol. II, p. 532 and 534.

[5] Canal Laws, N. Y., 1825, Vol. II, p. 93.

Rock Harbor, and entered into contract with the Black Rock Harbor Company to construct same, with a towpath on the east side of the harbor, for the sum of $95,819, guaranteed to stand for five years, and to be completed by December 1, 1824.[1] The pier is built of cribs, filled with stone, 16 feet high and 18 feet wide, from Bird Island to Ferry Street and from thence to Squaw Island. The bottom being of sand the cribs were made 20 feet wide at the bottom, receding to 16 feet at the top, the sloping side being made next to the harbor with a view of holding brush and sand.[2] The top was to be at low-water level, so that the surplus water could discharge into the river without endangering the docks in the harbor.[3] The total length of this pier is 530 rods. The embankment on Squaw Island is 8 feet high and 260 rods long, and the dam from Squaw Island to the mainland is on an average of 12 feet deep and about 30 rods long. A timber ship lock was to be built in the dam near its eastern end. This plan also provided for a canal from the upper end of the harbor to the Little Buffalo Creek (Commercial Slip) to connect the canal with Buffalo Harbor.

In the annual report of the canal commissioners, dated March 4, 1825, they state that the "pier, dam, and lock are well along," so that it is evident that the work was not completed at the time called for in the contract. They must have been completed during the year 1825, though, since the Erie Canal could not have been opened before their completion, and that was opened in October, 1825.

Frequent breaks occurred in the pier for the first few years of its existence, and occasional ones have occurred ever since. The most serious break occurred in 1827 or 1828, when the traverse pier was swept away by the ice. This portion of the pier and all south of it was held by the canal board not to be a portion of the canal and they refused to repair it.[4] General Porter obtained from the General Government, in the general harbor appropriation bill for 1829, the sum of $30,000 for Black Rock Harbor, and in 1830 another appropriation of $3,000 was made.[5] "These appropriations were used in repairing the pier and building a new pier out from the mainland near the foot of York street" (near Porter avenue). (I have not been able to verify the building of this pier at this date. I find no other record of it and no maps I have seen show it.[5] A pile jetty was built on about this location in about 1870.) "This pier has long since disappeared."[5]

About the year 1833 or 1834 Thompson S. Brown, United States Engineer Corps, proposed a plan to extend the Bird Island pier to near the mouth of Buffalo Creek, thereby making a large outer harbor and protecting the passage between the two harbors of Buffalo and Black Rock. Mr. Brown subsequently went to Russia on an invitation of the Czar to build a railroad.[6]

The repairs or rebuilding of the Black Rock pier was begun in 1837 and was done after the following plan: Above the Frontier Mills the work is entirely of stone. The top is 20 feet wide and is raised about 18 inches above the surface of the water in the harbor. It is laid in the form of a curve, extending from the water in the harbor to that in the river. The inner or harbor side has a slope of 1 on 2 below the water. The entire surface above the water is covered with broad heavy flagging, compactly laid. This plan of enlarging and strengthening the pier was mainly induced by the destructive breaches made by ice in the fall of 1836 and the spring of 1837.[1]

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[1] Canal Laws, N. Y., 1825, Vol. II, p. 532 and 534.

[2] Canal Laws, N. Y., 1825, Vol. II, p. 197; also Buffalo Historical Society. Paper by R. Williams.

[3] Canal Laws, N. Y., 1825, Vol. 11, p. 544.

[4] Buffalo Historical Soc. Pub., Vol. I, p. 153; also paper, R. Williams, in B. H. S. library; History of Buffalo, H. P. Smith, Vol. II, p. 95. See tracing of map Buffalo and Black Rock harbors, 1847, by P. Emslie, for traverse pier.

[5] Buffalo Historical Society. Paper by R. Williams, 1865.

[6] Buffalo Historical Society. Paper by R. Williams, 1865. See small tracing for details of plan.

Below the Frontier Mills the foundation of an outer work was laid in 1838. This work consisted of cribs filled with stone, is about 1,500 feet long, and from 25 to 50 feet outside of the old pier. The water here is from 7 to 14 feet deep, and the pier is to be raised 5 feet above the water surface in the harbor, and the top is to be covered with a heavy stone coping.[1]

In 1847 the common council of the city of Buffalo invited the canal board to visit Buffalo to inspect the harbor facilities and consider the plans for improvement proposed by the city.[2] Late in July of that year eight members of the board, with the chief and resident engineers, complied with the request. The plans proposed by the city included a basin and slip on the present site of the Ohio basin, the completion of the Hamburg Canal, and a ship canal to connect the Black Rock Harbor with the Buffalo Creek near its mouth.[3] This canal was to be 300 feet wide and to be connected with the Erie Canal by three slips near its southern end. A breakwater, extending from Bird Island pier to the mouth of Buffalo Creek, was to protect the canal, slips, etc., from the lake storms, all as shown on the map referred to above. The plan was modified by the canal board by extending the ship canal only about one-half mile from the Buffalo Creek, which was to the west side of Slip No. 3, with the idea of subsequently extending it to Black Rock Harbor, as proposed. The rest of the plan remained unchanged.

This plan of a ship canal on the Erie Basin, as it was subsequently named, was changed or enlarged to include approximately all of the land between the lake and the inner or northern boundary line, as shown on the map[3] referred to above. The area included in the revised plan is shown on the map, "Erie Basin and Slips," compiled and drawn under the direction of Maj. T. W. Symons, 1901. This map also shows the present location of the breakwater, dock lines, and slips.

At about the same date, 1847, a canal was proposed to be cut through Squaw Island from north to south, parallel to the harbor, to be used principally for the development of hydraulic power.[4] This canal was to be 200 feet wide and 10 feet deep and was to serve as a tail race for mills located between it and the harbor, as well as for navigation.[5] A company called "The Niagara River Hydraulic Company" was formed, and spent about $1,000 in making excavations, when the canal board put a stop to the enterprise. The board realized that too many mill rights had been granted already for the good of the canal.

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[1] Canal Commissioners' Report, 1839, p. 13.

[2] Canal Commissioners' Report, 1847, pp. 59 and 64; Common Council Proceedings, 1847–48. (See Eng's Index to Streets for Erie Basin.)

[3] See tracing map, Buffalo and Black Rock Harbor.

[4] Buffalo Historical Society. Paper by R. Williams, 1865.

[5] See tracing of map Buffalo and Black Rock Harbor, 1847.

The old ship lock to the Niagara River was built of timber, and it soon decayed and leaked badly. A new stone lock was begun at the west end of the dam in 1841, but was abandoned early in 1842, with the suspension of operations on the canal enlargement. It was again put under contract in 1849 and finished in 1851.[1]

One of the arguments urged in favor of Black Rock Harbor was the large amount of hydraulic power which would be made available by the dam. The mill rights were sold in 1826. The State obtained an annual rental for them, the titles becoming void when rents were not kept up. The rents amounted to $1,526.25 in 1865.[2]

Almost from the very first it was discovered that the interests of the canal and the millers were opposed. During the season of low water it was found impossible to run the mills and keep the canals supplied with water. Consequently the mills had to lay idle about three months every year. This difficulty increased as the harbor filled up with deposits of sand and mud. The State never did much in the way of cleaning out the harbor except to keep a channel open for canal boats. As late as 1845 vessels loaded with wheat could go down the harbor, but since then none but light-draft boats ever enter the harbor from above. Boats loaded with coal for Pratts Iron Works enter through the ship lock from below.[2]

In August, 1857, the canal board gave the Buffalo and Lake Huron Railway permission to construct a swing bridge across the harbor at the point where "Dutch Bill's" place is now located. This permission was granted with the understanding that a waterway of 3,500 square feet should be kept open. This condition was not complied with, and the piers formed a convenient obstruction, around which the sand accumulated.[3]

Serious interruptions to navigation frequently occurred at the intersection of the canal from Buffalo with Black Rock Harbor. In times of severe gales down the lake it was impossible to pass into or out of the canal. In 1840 the canal commission proposed to change the location of the line of the canal here and enter the harbor lower down. Another reason advanced for this proposed change of line was the accumulation of sand in the canal at the point of intersection with harbor which was washed in by storms from the lake. I do not think this change of line was ever made, since I can find no record of it, and the later maps show no change.[4]

Sometime between 1854 and 1861 a division wall was built 70 feet from the tow path of harbor up to within 2 feet of the water surface, extending from the mouth of the Buffalo Canal to about Ferry street. In 1861 the canal commissioners recommended that this wall be continued and raised to the high-water surface. Evidently this work was done sometime previous to 1867, since a map accompanying the annual report for that year shows this wall in full lines. I find no other record of its being raised.[5] [6]

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[1] Canal Commissioners' Reports, 1841 and 1850.

[2] Buffalo Historical Society. Paper by R. Williams, 1865.

[3] Buffalo Historical Society. Paper by R. Williams, 1865. See tracing map of Erie Canal and Black Rock Harbor. Canal Commissioners' Report, 1867.

[4] Canal Commissioners' Report, 1840.

[5] Canal Commissioners' Report, 1861, p. 102.

[6] Since canal commissioners in annual report, 1854, report in favor of 150-foot channel at this point and do not mention submerged wall.

At the lower end of the harbor the principal difficulties arose from the drawing of the water to supply the mills from the canal just above the guard lock. At times of low water not enough could be passed to supply the mills and canal. To obviate this trouble a tight wall of cement masonry was built on the berme bank between the mills and the canal when the canal was enlarged in 1854 and 1855, and the mills drew their supply of water through the old ship lock, from the harbor.[1]

The State engineer and surveyor in his annual report for 1871 outlines a plan for widening the narrow canal through Black Rock Harbor. He states that a greater part of the water to supply the mills and canals to Montezuma has to be drawn through the narrow canal, which is only 70 feet wide, and this creates such a strong current that boats have considerable difficulty in making headway against it. He recommends that the present division bank be removed to the north so as to make a canal 150 feet wide, this to extend from the railroad bridge to a little below Ferry street, and eventually all the way through the harbor. This idea of separating the canal and the harbor was proposed or suggested by the canal commissioners in 1861. They state that "it is desirable to have the fountain of supplies for canal and mills separated."[2]

The division wall as proposed above was well under way in 1872[3] and subsequently was carried nearly to Forest avenue, with an opening of about 260 feet from Potomac avenue south. The opening between the canal and harbor at the upper or south end of the latter was also closed at this time. This wall is built of cribs and earth, and at present the cribs are surmounted by a dry rubble wall on each side filled between with earth. The entire separation of the canal and harbor was never effected. The openings noted above still exist.[4]

The extension of Bird Island pier, the raising and repairing of the rest of the pier, and the building of a pile jetty pier near the foot of Porter avenue was completed in 1872.[5] These improvements were begun in 1869 and 1870 and raised the water in the harbor about 10 inches. The above extension of Bird Island pier was the first one made above Bird Island, and was built of timber cribs surmounted with a timber superstructure.

Extensive repairs were made to the pier in 1889 and in 1899.[6] An extension of 900 feet was made in 1891 and 1892. This extension was a timber structure composed of cribs, 20 feet wide by 50 feet long, surmounted by a timber superstructure.[7]

The timber extension above Bird Island as it now exists is about 3,100 feet long, and is well protected by heavy stone riprap all along its lake face.[8]

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[1] Canal Commissioners' Report, 1854. Also Buffalo Historical Society; paper by R. Williams, 1865.

[2] Canal Commissioners' Report, 1861, p. 102.

[3] Canal Commissioners' Report, 1872.

[4] See assessor's maps, City Hall.

[5] Canal Commissioners' Report, 1870, p. 170. Also State Engineer's Report, 1872, p. 84.

[6] Superintendent Public Works' Report, 1889, pp. 144, 146. Also State Engineer's Report, 1889, p. 221.

[7] Superintendent Public Works' Report, 1891, p. 117; also same for 1892, p. 108.

[8] See map Lake Erie Entrance to Black Rock Harbor and Erie Basin.

REPORT OF OPERATIONS.

This work consisted of the construction of a breakwater 2,200 feet long, which covers and protects the entrance to Erie Basin and Black Rock Harbor, between the New York State structures known as the Erie Basin breakwater and the Bird Island pier. The plans call for a timber crib substructure, one-half to be 36 feet wide and the remainder 24 feet wide, and the depths varying from 22 to 6 feet to accommodate the varying depths of water to the rock. The superstructure is a shell of concrete from 3 to 5¾ feet thick, filled inside with stone, and rests on top of the cribs, which are sunk to 2½ feet below mean lake level. The work was done by J. B. Donnelly, under contract dated August 4, 1899.

Operations first began August 25, 1899, on trench excavation, and the breakwater was finally completed June 4, 1901.

On July 1, 1900, 2,000 linear feet of timber crib had been placed and filled with stone, the remaining 200 linear feet of cribs were ready to be sunk in place, and 86 concrete blocks had been made.

The placing of concrete blocks began at the south end on July 23, and the first concrete was molded in place on section 1 on August 31, 1900. At the close of the season of 1900 the 2,200 linear feet of cribs had been sunk in place and filled; 29 sections, aggregating 1,450 linear feet of concrete blocks, had been set and accepted, and 24 sections of mass concrete had been placed and paid for; 8 concrete blocks had been set on section 30, and the mass concrete had been partly laid on sections 25 and 26, but not paid for; 95 concrete blocks were made ready to set.

Unfavorable weather conditions prevailed during July and a part of August, so but very little work could be done. During the remainder of the season reasonably good weather prevailed. There were exceptions, however, and two unusually severe windstorms visited Buffalo during the fall. The first one, usually called the Galveston storm, occurred on September 11 and 12. The wind reached a velocity of 78 miles per hour and the water rose to 5.6 feet above mean lake level. This gale found the breakwater work in poor condition to stand such a strain. The walls of mass concrete had just been completed on sections 1 and 2; 1,380 linear feet of lake face blocks, 1,190 linear feet of harbor face blocks, and 1,000 linear feet of middle and cross wall blocks were in place. The two sections of walls of mass concrete showed considerable settlement, and quite a good many cracks were made in all of the walls. However, it was not considered that the damage was sufficient to justify their removal. The decks on these sections were placed after the storm and were made extra thick and strong, so as to form a strong bond over the top of the walls.

All of the lake and harbor face blocks not covered by concrete were displaced, and a total of 188 blocks were washed off the cribs. The middle and cross wall blocks were made in place, and with the exception of one section, which was placed the day previous to the storm, remained intact. The stone filling was in up to the top of the blocks about as far as the latter were in place, and nearly all of this, or about 1,664.3 cubic yards, was washed out. This storm caused a very serious delay, as well as a great expense to repair and replace the damaged and displaced parts. The blocks had been accepted and most of them were paid for, consequently the Government had to bear the expense of recovering and resetting.

A minor storm occurred on November 1 and 2, which destroyed most of the forms and damaged the face of the superstucture of section 20, the walls of which had been placed the day previous.

The second severe storm occurred on November 21, when the wind attained a velocity of 80 miles per hour, with an average velocity of 59 miles per hour for 12 hours, and the water rose to 6.3 feet above mean lake level. This storm found the work in better condition than the previous storm did; nevertheless considerable damage was done. The superstructure walls of section 26 were about half taken out, the harbor wall being washed bodily into the harbor, carrying with it all of the harbor face blocks on the section. The deck and harbor wall on section 25 were quite badly cracked. A total of 16 concrete blocks which had been set in place were washed off the cribs, and about 850 tons of filling stone was washed out of the cribs and uncompleted superstructure. The whole breakwater showed evidences of more or less settlement, as small cracks showed in several places, but no serious damage resulted except as noted above.

No work was done after this storm in the season of 1900 except to place the unset concrete blocks along the unfinished work so as to protect it as well as possible during the winter. There were 93 of these blocks on hand.

Work was resumed this spring on March 25, when the removal of the remainder of mass concrete on section 26 and the recovering and resetting of concrete blocks displaced by storm of November 21 began. This was necessarily very slow work, as a good deal of it had to be done by divers. Two divers were kept busy most of the time until the work was completed, on April 22. The setting of blocks not previously set began on this date. The last concrete blocks, except the two specials for the north end of the lake and harbor face, were made on April 23. The laying of mass concrete was resumed on April 24 on section 26. From this date the work was pushed with vigor. Very favorable weather prevailed, and the breakwater was finally completed on June 4, 1901.

The total cost of the breakwater was as follows:

41,657 cubic yards trench excavation, at 20 cents	$8,331.40
7,133 tons of riprap stone, at 84 cents	5,991.72
9,325 tons of foundation stone, at 69 cents	6,434.25
300 linear feet of 22 by 36 foot cribs, at $62	18,600.00
300 linear feet of 20 by 36 foot cribs, at $56	16,800.00
500 linear feet of 18 by 36 foot cribs, at $48	24,000.00
200 linear feet of 16 by 24 foot cribs, at $30	6,000.00
200 linear feet of 12 by 24 foot cribs, at $24	4,800.00
400 linear feet of 10 by 24 foot cribs, at $21	8,400.00
300 linear feet of 6 by 24 foot cribs, at $15	4,500.00
13,640.9 tons filling stone, at 69 cents	9,412.21
4,613.75 cubic yards concrete blocks, at $7.10	32,757.63
12,320.9 cubic yards of mass concrete, at $5.65	69,613.08
70 manhole covers, at $3	210.00
12 mooring rings, at $50	600.00
3,774 pounds of iron (anchor bolts and plates), at 10 cents	377.40
Total	216,827.69
Cost of recovering and replacing concrete blocks and stone filling washed from the breakwater by storms	6,000.00
	222,827.69
Engineering and office expenses	13,450.41
Total	236,278.10

REMARKS.

This northerly breakwater, in connection with the Government breakwater built and under construction to the south, and the New York State Bird Island pier to the north, will complete the protection of Buffalo Harbor and shore line all the way from Stony Point to Black Rock, about 7½ miles. There are sent herewith 3 photographs illustrating the work.

Money statement.

July 1, 1900, balance unexpended	$145,548.71
June 30, 1901, amount expended during fiscal year	140,125.56
July 1, 1901, balance unexpended	5,423.65

APPROPRIATIONS.

March 3, 1899	$50,000.00
June 6, 1900	191,701.25
Total	241,701.25

COMMERCIAL STATISTICS OF BUFFALO ENTRANCE TO ERIE BASIN AND BLACK ROCK HARBOR, NEW YORK.

For the commercial statistics relating to this work reference is made to the statistics of Buffalo Harbor. There are no means of separating the statistics relating to the portion of the harbor covered by this improvement from the general statistics of the harbor.

R R 5.

IMPROVEMENT OF TONAWANDA HARBOR AND NIAGARA RIVER, NEW YORK.

ORIGINAL CONDITION.

In its original condition the navigation of the Niagara River from Lake Erie to Tonawanda was obstructed by several reefs and hummocks which materially limited the draft of vessels traversing it. The water in the harbor between Tonawanda Island and the main shore was shoal, and the river in some places had a very swift current. The object of the improvement is to provide a navigable channel from the head of Niagara River at Lake Erie to the north end of Tonawanda Harbor, and to dredge that harbor, all to a depth permitting use by vessels drawing 16 feet.

PROJECT FOR IMPROVEMENT.

To remove obstructions so as to make a channel 400 wide and 18 feet deep, which, as planned, includes work at the following places:

1. On the Horseshoe Reef at the entrance to Niagara River.
2. On the shoal at the head of Strawberry Island.

3. A few shoal places abreast of the lower end of Rattlesnake Island.

4. The full width of the river between Tonawanda Island and the mainland along the entire front of Tonawanda.

The project was approved in 1888.

By the terms of the river and harbor act of June 3, 1896, the project was extended to include the river to the north line of the village of North Tonawanda.

The cost of the work as estimated in 1891 was $1,152,987.93. This does not include the work necessary between Tonawanda Island and the north line of the village of North Tonawanda, nor that required in the main river abreast of Tonawanda Island, to which the project was extended by the terms of the river and harbor act of June 3, 1896. The amount expended on the general project up to June 30, 1900, was $413,671.23.

At that time the channel through the Horseshoe Reef had been completed. This channel is 400 feet wide and 18 feet deep at mean lake level, excepting a few small patches of rock over which there is a least depth of 17½ feet. The length of the channel is 1,500 feet.

The amount expended during the fiscal year ending June 30, 1901, was $9,614.06.

At the close of operations in 1897, due to exhaustion of funds, the channel across the reef at Strawberry Island had been excavated to a depth of 18 feet for a width of 180 feet.

In June, 1899, operations in rock removal were recommenced and continued until July 31, 1900, when the channel was practically completed as planned.

During the season of 1896 a channel 200 feet wide and 1,050 feet long was excavated fully 18 feet deep across the shoal in the main river channel at the foot of Tonawanda Island. Tonawanda Harbor had been dredged 16 feet deep in the center during previous years. The work of increasing the depth in the harbor to 18 feet was begun in 1895, when a dredge cut 20 feet wide was made to the depth of 18 feet along nearly all the length of the harbor front of Tonawanda Island. During 1897 the money available was expended in securing a similar depth along 1,600 feet of the docks on the mainland side below the bridge for a width of 75 feet.

During the fiscal year ending June 30,1900, a large amount of work was done in removing a troublesome shoal at the foot of Tonawanda Island, which prevented vessels from safely approaching the iron-works dock. One dredge worked on this shoal from July 1 to December 9, 1899.

The object of the extension of the project to the north line of North Tonawanda was to enable needed work to be done on a shoal off the foot of Tonawanda Island, which work was not included in the original project and estimates. At some distance below the island there is a deep pool, and by excavating across the shoal this would be reached. Beyond the pool no work is demanded by any present interests of commerce.

REPORT OF OPERATIONS.

At the beginning of the fiscal year dredging Strawberry Island channel was nearly completed. Work was continued during the month of July, 1900, with one dredge, under contract with Hingston & Woods.

During the month 8,940 cubic yards of gravel was removed and the channel completed.

No other work has been done during the year.

REMARKS AND ESTIMATE.

The originally estimated cost of the project in 1891 was $1,152,987.93. A very large part of the work embraced by the project and its extension has been done at a cost much below the original estimate.

Taking the sum of the appropriations, $425,000, from the original estimates leaves $727,987.93. The knowledge gained in the conduct of the work indicates that but a portion of this sum will be required to do all the necessary work embraced in the original project and all work that is at all required in the extension of the project.

Recent experiences of vessels and an examination made by this office imply a lumpy condition and some shoal ridges in the main channel abreast of Tonawanda Island, which will require much work to give the projected channel 18 feet depth and 400 feet width. This work is not specified or estimated for in the original project and estimate, but properly comes within the extended project.

The commerce of Tonawanda is large and increasing, and it is in a high degree desirable that all impediments be removed which interfere with vessels reaching the docks drawing 16 feet at mean level of the lake and river. An appropriation of $250,000 is estimated for as the amount which can profitably be expended during the next fiscal year under the project.

Money statement.

July 1, 1900, balance unexpended	$11,328.77
June 30, 1901, amount expended during fiscal year	9,614.06
July 1, 1901, balance unexpended	1,714.71
Amount (estimated) required for completion of existing project	727,987.93
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	250,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

Act of—	
August 11, 1888	$100,000
September 19, 1890	75,000
July 13, 1892	75,000
August 18, 1894	50,000
June 3, 1896	50,000
March 3, 1899	75,000
Total	425,000

COMMERCIAL STATISTICS OF TONAWANDA HARBOR AND NIAGARA RIVER, BY LAKE AND RIVER.

[Furnished by the collector of customs, Buffalo Creek and Niagara districts.]

Arrivals and departures of vessels for the year ending December 31, 1900.

District.	Arrivals from—				Departures to—			
	Home ports.		Foreign ports.		Home ports.		Foreign ports.	
	Number.	Ton. nage.	Number.	Tonnage.	Number.	Tonnage.	Number.	Tonnage.
Buffalo Creek:								
Steam	79	38,464	26	2,494	86	40,326	28	2,142
Sail and barges	86	40,233	7	2,737	88	41,121	3	847
Niagara:								
Steam	281	188,020	29	10,499	284	182,028	26	8,960
Sail and barges	363	185,688	36	12,499	363	188,291	28	9,274
Total	809	452,405	98	28,219	821	451,766	85	21,223

Total arrivals and departures (registered tonnage).

	1899.				1900.			
	Arrivals.		Departures.		Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.	Number.	Tonnage.	Number.	Tonnage.
Buffalo Creek	249	114,188	246	114,720	198	83,918	205	84,436
Niagara	820	450,044	827	449,125	709	396,706	701	388,553
Total	1,069	564,182	1,073	563,845	907	480,624	906	472,989

Decrease of tonnage, 1900 under 1899	174,414
Greatest draft of vessels ....feet	14
Amount of revenue collected, year ending December 31, 1900[1]	$46,029.64
Value of foreign imports, year ending December 31, 1900[1]	$446,250.00
Value of foreign exports, year ending December 31, 1900[1]	$7,256.50
Enrolled tonnage, port of Tonawanda	No record
New lines of transportation established	None
Number of rafts of timber received	23

Receipts by lake and river.

[Tons of 2,000 pounds.]

Articles.	1894.	1895.	1896.	1897.	1898.	1899.	1900.
Lumber	712,087	737,202	821,797	1,024,232	819,353	870,083	680,597
Shingles	3,776	4,597	4,298	5,948	9,441	1,740	6,662
Laths	2,124	2,137	1,798	1,882	901	420	407
Pickets			135		81		
Posts	1,200	1,167	4,059	2,889	3,439	1,710	5,208
Railroad ties, telegraph poles, etc	2,514	7,350	5,972	2,196	13,120	24,751	34,422
Iron ore	93,684	110,454	134,428	172,187	245,417	237,290	222,450
Limestone		21,720	4,770	4,358	3,037	6,449	3,843
Pig iron	4,370	8,371	9,097	2,408	3,151	1,979	6,180
Copper	700						
Pulp wood	17,812		25,270	19,720	24,648	7,180	
Timber		1,050	3,772	5,057			1,209
Miscellaneous					216		595
Total	838,267	894,408	1,015,396	1,240,867	1,122,807	1,151,602	961,573

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[1] Niagara district only.

Shipments by lake and river.

[Tons of 2,000 pounds.]

Articles.	1897.	1898.	1899.	1900.
Lumber	928	70	....	....
Pig iron	500	....	....	453
Manufactured iron	200	....	....	....
Total	1,628	70	....	453

Receipts, in tons and percentages, for the years ending December 31, 1898, 1899, and 1900.

Articles.	1898.		1899.		1900.	
	Tons.	Per cent.	Tons.	Per cent.	Tons.	Per cent.
Timber and timber products	870,986	77.57	905,884	78.66	729,100	75.82
Iron, copper, etc	251,821	22.43	245,718	21.34	232,473	24.18
Total	1,122,807	100	1,151,602	100	961,573	100

Entrances and clearances at Tonawanda since 1892.

[Compiled from the annual report of the Buffalo Merchants' Exchange.]

Year.	Vessels entered.		Vessels cleared.		Articles received by lake, in vessels, rafts, etc.	Canal clearances.	Shipments by Erie Canal.	Lumber shipments by Erie Canal.
	Number.	Tonnage.	Number.	Tonnage.				
					Tons.	*Number.*	*Tons.*	*Feet B. M.*
1892	1,181	484,088	1,175	473,997	996,376	3,111	584,212	286,329,307
1893	909	400,479	894	391,175	860,142	2,502	550,864	216,116,532
1894	849	418,438	830	403,350	838,267	2,258	436,260	202,110,990
1895	920	425,105	935	441,602	894,408	2,120	403,358	195,886,000
1896	1,305	466,297	1,278	455,000	1,015,396	2,062	384,889	185,580,352
1897	1,356	557,748	1,369	558,786	1,240,867	2,735	502,527	218,576,701
1898	1,137	552,670	1,130	55,091	1,122,807	2,100	453,998	184,709,746
1899	1,059	564,098	1,059	56,228	1,151,602	....	415,051	174,294,366
1900	907	480,624	906	472,989	961,578	....	899,437	154,973,108

Number of rafts and vessels passing the International Bridge, Niagara River, during the years 1893 to 1900.

[Furnished by R. J. McMurray, captain of the tug *International.*]

	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.
Steamers	8,796	10,408	10,012	9,469	8,100	7,325	6,108	7,332
Other vessels	2,820	3,075	2,891	1,833	2,321	1,960	1,506	1,495
Rafts	25	13	5	13	10	4	2	....
Total	11,641	13,496	12,908	11,315	10,431	9,289	7,616	8,827

Number of vessels passing through the draw of the International Bridge.

Vessels.	1896.	1897.	1898.	1899.	1900.
Tugs	3,213	....	2,441	2,572	2,757
Steamers	2,856	4,250	2,360	2,404	2,900
Barges	1,608	2,321	1,598	1,638	1,650
Total	7,677	6,571	6,399	6,614	7,307

Season of navigation, May 15 to December 21, 1900	days..	220
Number of times the bridge draw was opened during season		4,905
Average number of times bridge draw was opened per day		22.3

R R 6.

IMPROVEMENT OF NIAGARA RIVER FROM TONAWANDA TO PORT DAY, NEW YORK.

ORIGINAL CONDITION.

Port Day is the inlet to the old hydraulic-power canal at Niagara Falls. It is not and never has been a practicable port of commerce, owing to shallow water and its proximity to the rapids at the head of Niagara Falls.

From Port Day up the river in front of the city of Niagara Falls is very shallow and with rock bed until Conners Island is reached. Between Conners Island and the main shore is a snug little harbor, with about 5 acres of an average depth of 12 feet at mean river stages, and with a maximum depth of about 16 feet.

Above the head of the island there was a shoal with a least depth on it of 7½ feet at mean stage. Above this shoal very good water existed until Cayuga Island was reached. Between this island and Tonawanda a shoal exists which requires dredging to give a channel of 12 feet depth at mean river stage.

PROJECT FOR IMPROVEMENT.

The project for the improvement of the Niagara River from Tonawanda to Port Day, as it now stands, is to make a channel 200 feet wide and not less than 12 feet deep at mean river level by excavating through the shoal at the head of Conners Island and through the shoal above Cayuga Island.

The project also states that "any widening or deepening required should be estimated and provided for after the work outlined above is done."

This is a modification of the original project, which, with a history of the modification, is given in the annual report on this harbor for 1896. (Chief of Engineers' Report, p. 3122.)

The cost of the present project was originally estimated in 1892 at $230,000. This estimate was reduced to $180,000, and it is now estimated that the work can be completed for much less than this amount, viz, $35,000, making the total cost of the work contemplated by the project $95,000.

Up to June 30, 1900, there had been expended on the project $58,210.86. At this time the channel through the shoal at the head of Conners Island had been completed to its full width of 200 feet and a depth of 12 feet or more at mean river level. Across the shoal above Cayuga Island a channel was drilled, blasted, and dredged to a depth of 12 feet, a width of 81 feet, and a length of 1,040 feet, extending entirely across the shoal.

The amount expended during the fiscal year ending June 30, 1901, was $1,430.65, being retained percentages due contractor.

The channel through the shoal above Cayuga Island was excavated to the required depth of 12 feet and to a width of 150 to 170 feet, leaving from 30 to 50 feet yet to be excavated to complete the channel under the project. This channel has been properly buoyed by the Light-House Department.

No operations have been carried on during the fiscal year ending June 30, 1901.

REMARKS.

With the completion of the channel 200 feet wide and 12 feet deep through the Cayuga Island reef and the removal of any bowlders that may be elsewhere discovered the project may be considered as completed.

It is estimated that it will cost not to exceed $35,000 to complete the work on this shoal and elsewhere under the project, and it is therefore recommended that this sum be appropriated to complete the project.

It is to be noted that there is practically no use made of this channel of the Niagara River below Tonawanda except by excursion boats running to resorts along the shore of Grand Island.

Money statement.

July 1, 1900, balance unexpended	$1,789.14
June 30, 1901, amount expended during fiscal year	1,430.65
July 1, 1901, balance unexpended	358.49
Amount (estimated) required for completion of existing project	35,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	35,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

Act of—

July 13, 1892	$20,000
August 18, 1894	10,000
June 3, 1896	15,000
March 3, 1899	15,000
Total	60,000

COMMERCIAL STATISTICS, NIAGARA FALLS, N. Y.

Arrivals and departures of steam and sail vessels for the year ending December 31, 1900.

	Number.	Tonnage.
Arrivals	55	43,795
Departures	55	43,795

Total arrivals and departures (tonnage 87,590)	110
Increase of tonnage over 1899	54,580
Greatest draft of vessels ... feet	10
Amount of revenue collected, year ending December 31, 1900	None on lake commerce.
Value of imports, year ending December 31, 1900	$6,494
Value of exports, year ending December 31, 1900	None.
Enrolled tonnage, port of Niagara Falls	No record.
New lines of transportation established	None.

Receipts by lake and river at Schlosser's dock.

	1896.	1897.	1898.	1899.	1900.
Rosin, potash, clay, sulphur, nitrates, etc ... tons	None.	None.	None.	1,410	1,517

No record of passengers.

There was unloaded from vessels at foot of Grand Island and rafted to Port Day for the paper mills the following:

Year.	Pulp wood.	Year.	Pulp wood.
	Tons.		*Tons.*
1895	28,284	1898	84,418
1896	86,000	1899	76,000
1897	70,764	1900	52,000

Shipments by river, none, except passengers, which are not reported.

R R 7.

EXAMINATION AND SURVEY OF LAKE ERIE ENTRANCE TO BLACK ROCK HARBOR AND ERIE BASIN, NEW YORK.

[Printed in House Doc. No. 125, Fifty-sixth Congress, second session.]

Office of the Chief of Engineers,
United States Army,
Washington, December 3, 1900.

Sir: I have the honor to submit herewith copies of reports dated July 6 and November 8, 1900, with map,[1] by Maj. T. W. Symons, Corps of Engineers, upon preliminary examination and survey, respectively, of Lake Erie entrance to Black Rock Harbor and Erie Basin, New York, made to comply with requirements of the emergency river and harbor act of June 6, 1900.

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[1] Not reprinted; printed in House Doc. No. 125, Fifty-sixth Congress, second session.

The project presented for improvement contemplates the formation by dredging and rock removal of a channel 3,300 feet long, 400 feet wide, and 23 feet deep at mean lake level, except where bed rock is found at a depth of 22 feet, from Buffalo main entrance channel to Erie Basin, and a branch channel and basin, 1,920 feet long, 500 feet wide, and 23 feet deep at mean lake level, to Black Rock Harbor, the estimated cost being:

For channel to Erie Basin	$188,743
For branch channel and basin to Black Rock Harbor	625,900
Total	814,643

With reference to the advisability of this improvement Major Symons states that in his opinion existing commercial interests justify and require the excavation of the channel to Erie Basin, and that the branch channel to Black Rock Harbor is necessary for prospective commerce only. His views are concurred in by the Division Engineer, Col. G. L. Gillespie, Corps of Engineers.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

Hon. ELIHU ROOT,
Secretary of War.

PRELIMINARY EXAMINATION OF THE LAKE ERIE ENTRANCE TO BLACK ROCK HARBOR AND ERIE BASIN, NEW YORK.

UNITED STATES ENGINEER OFFICE,
Buffalo, N. Y., July 6, 1900.

GENERAL: I have the honor to acknowledge receipt of your letter of June 30, 1900, and to submit the following report on the preliminary examination of the Lake Erie entrance to Black Rock Harbor and Erie Basin, New York.

It is my opinion that this locality is worthy of improvement by the General Government. This opinion is based upon its present and prospective use for the purposes of commerce.

A portion of the map[1] of Buffalo Harbor is submitted herewith. Upon this map is shown the general situation of the locality included in this examination. The portion of the water front of Buffalo from the Erie Basin to the Bird Island Pier has never been improved to any great extent on account of its exposure to the storm action of Lake Erie. This is now being protected by the construction of the North Breakwater in the position shown in red on the accompanying map, and it will now be practicable to improve this portion of the harbor. As it directly connects with the main tracks of the New York Central Railroad, it will probably be improved and used for commercial purposes in a very short time.

Just to the north of the Erie Basin and jutting out from the mainland is shown what is known as the Reading coal trestle. Large amounts of anthracite coal are brought to this trestle over the lines of the Central Railroad and shipped therefrom in large vessels. It is very difficult for the large vessels to get to and from this trestle, and it is a common thing for a vessel to go aground just to the northwest of the Erie Basin breakwater, and a considerable portion of the work needed is to give relief from this grounding of loaded vessels.

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[1] Not printed.

The object of the improvement aimed at is understood to be to give access to this coal trestle and to the lake front northward from it. It is understood to be the intention of the city to build excursion docks along this portion of the water front, and the commerce to be benefited will, therefore, be both general and local.

The State of New York has recently spent about $30,000 in deepening the Erie Basin and better fitting it for commercial purposes, and this will add to the importance and necessity of the work under advisement.

It is estimated that to make the survey required will cost at least $300, and there is no former appropriation from which this could be supplied.

As stated in my letter of June 20, 1900, it will be necessary in making the survey and estimates of cost to fix upon the harbor line in front of this property, in order that the work of the Government may be properly limited. If the harbor line can not be established, it will be necessary to assume one and work from that as a basis, but it would be best for all interests to have this line fixed at once in order that there may be no misunderstanding in regard to the matter.

Very respectfully, your obedient servant,

T. W. SYMONS,
Major, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[Second indorsement.]

NORTHEAST DIVISION ENGINEER OFFICE,
New York, July 17, 1900.

Respectfully returned to the Chief of Engineers, concurring in the views of the district officer.

The city front north of entrance to Buffalo River, including the Erie Basin, has been improved by riparian owners at large expense during the past five years to render it more available for the increasing commerce of the port. The construction of the north breakwater will place this front under protection and will cause the improvements just completed to be utilized to advantage.

A Government harbor line on this front is desirable.

G. L. GILLESPIE,
Colonel, Corps of Engineers,
Division Engineer.

[Third indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
July 18, 1900.

Respectfully submitted to the Secretary of War.

This report relates to preliminary examination of the Lake Erie entrance to Black Rock Harbor and Erie Basin, Buffalo, N. Y., authorized by the emergency river and harbor act approved June 6, 1900.

In view of its present and prospective use for the purposes of commerce, the locality is reported to be worthy of improvement by the General Government, and I recommend that a survey be made and the cost of improvement be estimated.

A. MACKENZIE,
Acting Chief of Engineers.

[Fourth indorsement.]

WAR DEPARTMENT,
July 20, 1900.

Approved as recommended by the Acting Chief of Engineers.

ELIHU ROOT,
Secretary of War.

SURVEY OF LAKE ERIE ENTRANCE TO BLACK ROCK HARBOR AND ERIE BASIN, NEW YORK.

UNITED STATES ENGINEER OFFICE,
Buffalo, N. Y., November 8, 1900.

GENERAL: I have the honor to submit the following report on a survey and estimate of the cost of improvement of the "Lake Erie entrance to Black Rock Harbor and Erie Basin, New York," to comply with the provisions of the emergency river and harbor act of June 6, 1900, and your letter of August 25, 1900. There is submitted herewith a tracing of a portion of Buffalo Harbor, upon which is shown the entrance and locality understood to be embraced under this title.

The harbor works necessary for the improvement consist solely of the excavation of an approach channel and branches connecting the main entrance channel leading into Buffalo Harbor with Black Rock Harbor and with the Erie Basin. The approach channel is 3,000 feet long from the main Buffalo entrance channel to the northerly end of the New York State breakwater forming the Erie Basin, where it divides into two branches—one, a short branch to the southward, connecting this channel with the Erie Basin in front of the Reading coal trestle, and one a branch to the northward, connecting this channel with Black Rock Harbor at its upper end, where it is formed by the Bird Island Pier, a structure built by the State of New York. In addition to being a channel, however, for the passage of vessels into Black Rock Harbor, this northerly branch would have to serve as a basin in front of the wharves and slips which may be built out from the mainland to the established harbor line, and in planning the improvement this fact must be taken into consideration and the channel way widened accordingly.

The main approach channel proposed and the short branch to the southward should be the equal in width and depth of the main entrance channel into Buffalo Harbor, because it should accommodate vessels of the same class and size navigating the last-mentioned channel, viz, vessels of 18 to 20 feet draft and engaged in coal, grain, and lumber transportation.

The Reading coal trestle and the lumber yards and grain elevators bordering on the Erie Basin are commercial interests actually existing and to be benefited by the proposed improvement. These interests are now restricted to such traffic as can be done by vessels of not over 16 feet draft, the draft that can be carried through the natural channel way leading lakeward from the northerly end of the New York State breakwater.

The north branch of the proposed channel leading to Black Rock Harbor must be considered and planned in the light of prospective use for the purposes of commerce. The portion of the water front of Buffalo along which this part of the improvement is proposed, and which extends northward from the Reading coal trestle to the Bird Island pier, has never been improved heretofore, on account of its exposure to storms on Lake Erie. The conditions are now radically changed, as the breakwater for the protection of the entrance to Erie Basin and Black Rock Harbor has been provided for, is well along toward completion, and will be fully completed before July, 1901, and will thoroughly protect the entire frontage under consideration. The frontage connects directly with the main tracks of the New York Central Railroad, and it will probably be improved by the construction of wharves and slips for commercial purposes in a short time.

It is also possible that the city of Buffalo will build excursion wharves along a portion of this frontage, or beyond it in Black Rock Harbor, to meet an urgent demand for that class of traffic.

For the reasons herein stated, the improvement proposed has been designed and estimated for as shown on the accompanying tracing. The work may properly be divided into two portions; one leading to the Erie Basin being immediately necessary for the benefit of existing commerce, and one leading to Black Rock Harbor being necessary for prospective commerce only. These will be separately estimated for.

In all the work it is contemplated to carry the excavation to the depth of 23 feet at mean lake level. This depth is arrived at as follows:

The maximum draft of vessels coming to Buffalo is approximately 19 feet. Easterly windstorms often lower the water in the harbor 2 feet below mean lake level, and sometimes 3 feet. It is desirable to have at least 1 foot of water under a vessel at all times. To meet all these contingencies and always have at least 1 foot of water under the keel of vessels drawing 19 feet it is necessary to carry the excavation to 23 feet. Where, however, bed rock is found at a depth of 22 feet, it is not planned to disturb it.

The dimensions of the channels and basin proposed are as follows:

The approach channel from the main entrance channel to Buffalo Harbor at the opening between the two breakwaters, as shown, lies straight to the established harbor line, and is 3,000 feet long. This channel is to be 400 feet wide. In addition thereto, in order to give a clear entrance to Erie Basin, the area south of this channel should be excavated, as shown, an average distance of about 300 feet in length and an average width of 400 feet.

The Black Rock Harbor branch of the channel extends from the approach channel northerly to the southerly end of Black Rock Harbor, and is 1,920 feet long and 500 feet wide. This width of 500 feet is adopted in order that vessels entering or leaving the slips to be built between the harbor line and the shore may have room to make the necessary turns and straighten themselves out in the direction of the channel, and as well that it may accommodate the traffic going into and out of Black Rock Harbor.

CHARACTER OF MATERIAL.

Upon the map submitted the natural depths to lake bottom are shown in plain figures, and depths to rock are shown in figures inclosed in parentheses. In the entrance channel the rock is overlaid with sand, gravel, and clay to an average depth of about 6 feet. In the Black Rock Harbor channel and basin this depth of soft material is much less, averaging but about 1 foot. Over a large part of the area there is practically no soft material on the rock. The underlying rock which must be excavated to give the required depths is flinty limestone bed rock which will require to be drilled, blasted, and dredged.

ESTIMATE OF COST.

I.

The approach channel from Buffalo main entrance to the established harbor line at foot of Georgia street, with branch to Erie Basin—main channel 400 feet wide and 3,000 feet long; branch to Erie Basin 400 feet wide and averaging 300 feet long, all to a depth of 23 feet at mean lake level except where bed rock is found at a depth of 22 feet.

Dredging 247,000 cubic yards of sand, gravel, and clay, at 18 cents per cubic yard	$44,460
Excavating 56,500 cubic yards, place measure, of bed rock, at $2.25 per cubic yard	127,125
	171,585
Contingencies, engineering, superintendence, office expenses, etc., 10 per cent	17,158
	188,743

II.

For channel and basin leading from the entrance channel to Black Rock Harbor, 1,920 feet long, 500 feet wide, and 23 feet deep, at mean lake level:

Dredging 45,000 cubic yards of sand, gravel, and clay, at 20 cents	$9,000
Excavating 280,000 cubic yards, place measure, of bed rock, at $2	560,000
Contingencies, engineering, superintendence, office expenses, etc., 10 per cent	56,900
	625,900

SUMMARY ESTIMATE.

For main approach channel and entrance to Erie Basin, demanded by existing commercial necessities	$188,743
For channel and basin leading from main approach channel to Black Rock Harbor	625,900
	814,643

COMMERCIAL INTERESTS INVOLVED.

Your letter of August 25 requires me to give my opinion, "based upon the results of the survey, as to the amount of improvement that may be justified by the commerce involved, together with * * * reasons for such opinion; and a statement of the commerce to be benefited."

It is my opinion that existing commercial interests justify and require the excavation of the approach channel and branch to Erie Basin. Within and bordering on this basin are various structures used in connection with lake-shipping interests, coal trestles, lumber yards, grain elevators, flour and package freight warehouses, shipbuilding and repair shops, etc. The region has always been handicapped by the difficulty of getting to it. The large vessels running from the Reading coal trestle frequently go aground in the narrow and poor natural channel to the north of the Erie Basin breakwater.

It is not practicable to make a statement as to the amount of commerce to be benefited by this particular portion of the improvement, as the statistics regarding it are embraced in the statistics of Buffalo Harbor as a whole. The amount, however, is considerable and will undoubtedly be largely increased if better facilities are given for its being reached by deep-draft vessels.

For the portion of the proposed work leading from the main approach channel northward to Black Rock Harbor, not so much can be said. It has no present existing water commerce to be benefited, and all the benefits are prospective. This region is very advantageously situated for commercial purposes; the main tracks of the New York Central Railroad run right along the shore; there is a good, easily reached rock foundation for structures requiring strong foundation, and it is conveniently situated right in the middle of the city's water front. This portion of the harbor has never hitherto been improved for commercial purposes, as, in addition to its shallowness, it has been fully exposed to the lake storms, and it was entirely impracticable to build wharves and slips, etc., and maintain them. The north breakwater, now nearly completed, will give the required protection from the lake storms, and it is believed that the advantages of the frontage will cause its general improvement to immediately follow the excavation of a deep channel and basin outside the established harbor line.

Very respectfully, your obedient servant,

T. W. Symons,
Major, Corps of Engineers.

Brig. Gen. John M. Wilson,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[Third indorsement.]

Northeast Division Engineer Office,
New York, November 22, 1900.

Respectfully returned to the Chief of Engineers, concurring in the views of the district officer.

The work herein outlined makes possible the utilization of the water front of the city lying north of the entrance to Buffalo River in connection with the north breakwater now in process of construction, and in addition furnishes a basin in which vessels may lie securely protected against southerly and southwesterly storms.

G. L. Gillespie,
Colonel, Corps of Engineers,
Division Engineer.

R R 8.

ESTABLISHMENT OF HARBOR LINES IN ERIE BASIN AND BLACK ROCK HARBOR, BUFFALO, NEW YORK.

United States Engineer Office,
Buffalo, N. Y., September 4, 1900.

General: In accordance with the requirements contained in your letter of July 23, 1900, relating to the establishment of harbor lines in connection with a preliminary examination of Lake Erie entrance to Black Rock Harbor and Erie Basin, Buffalo, N. Y., I have the honor to submit the following report:

The object of the proposed harbor lines is fully set forth in my reports of June 20 and July 6, 1900, and need not be repeated here. I have communicated with many persons in the locality to be affected by the harbor line, and, after fully considering the matter, I have the honor to recommend the adoption of the harbor lines as shown on a tracing[1] submitted herewith. The harbor lines are laid down with due regard to all existing wharves, and at the same time provide what are believed to be ample accommodations for the future probable development of commercial interests in the locality.

The harbor lines have been designed for the entire Erie Basin and the entire frontage of Black Rock Harbor to the point where that frontage practically terminates, viz, to the masonry-faced embankment which alone separates Black Rock Harbor and the Erie Canal.

The proposed harbor lines are defined and described by references to street lines in order that there shall be no misunderstanding or ambiguity, and a description of the lines is submitted herewith in a separate paper.

The only points at which the proposed harbor line is inside of any existing structures are at the outer end of the north pier, where it cuts off a projection erected by the Delaware, Lackawanna and Western Railroad in connection with its illegal occupation of the north pier, and at the outer end of the protection jetty of the Reading coal trestle. The proposed harbor line cuts off about 40 feet of this protection jetty.

It is not intended that these projections beyond the harbor line should now be removed, but as a declaration that they are unauthorized and beyond the harbor line, and to be removed whenever the interests of commerce may require, and that they are not to be rebuilt if they should be destroyed.

This description should be attached to the tracing and form a part of the instrument.

I recommend that the harbor line as laid down be approved by the Secretary of War. * * *

Very respectfully, your obedient servant,

T. W. Symons,
Major, Corps of Engineers.

Brig. Gen. John M. Wilson,
Chief of Engineers, U. S. A.

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[1] Not printed.

[Third indorsement.]

U. S. ENGINEER OFFICE,
Buffalo, N. Y., October 1, 1900.

Respectfully returned to the Chief of Engineers, through the division engineer, with further report of this date.

T. W. SYMONS,
Major, Corps of Engineers.

[Fourth indorsement.]

NORTHEAST DIVISION ENGINEER OFFICE,
New York, October 3, 1900.

Respectfully returned to the Chief of Engineers, with recommendation that the harbor lines described in the accompanying report be approved.

G. L. GILLESPIE,
Colonel, Corps of Engineers, Division Engineer.

[Fifth indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
October 5, 1900.

Respectfully submitted to the Secretary of War.

It being deemed essential to the preservation and protection of the harbor at Erie Basin and Black Rock Harbor, Buffalo, N. Y., that harbor lines for the locality should be established, the subject was referred to Maj. T. W. Symons, Corps of Engineers, for consideration, and his report is contained in the within letter and in supplementary letter of the 1st instant herewith.

A public hearing was held and opportunity given the interested parties to present their views, and Major Symons now submits for approval the lines shown in red on the accompany tracing[1] and described in the accompanying paper. The only objection made to these lines was by one Howard Winship, whose protest against their establishment is herewith, but it is not believed that it should prevent the location of the lines as proposed in the interests of the general public.

I recommend that the lines be approved and that the Secretary place his approval on the tracing which has been prepared for his signature.

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

[Sixth indorsement.]

WAR DEPARTMENT, *October 12, 1900.*

Approved as recommended by the Chief of Engineers.

ELIHU ROOT,
Secretary of War.

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[1] Not printed.

REPORT OF MAJ. T. W. SYMONS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Buffalo, N. Y., October 1, 1900.

GENERAL: I have the honor to return herewith the papers relative to the establishment of the harbor lines in Buffalo from the entrance channel northward.

In accordance with the suggestion of the division engineer, a public meeting was advertised and held September 20, 1900, and quite a number of interested parties came to the meeting and examined the proposed lines. The lines as laid down met with very general approval. The city of Buffalo was represented by the city engineer and assistant city engineer, who looked over the lines carefully and approved them. The chairman and attorney of the city harbor commission were present and approved the lines. A representative of the assessor's office did the same. The representatives of the Delaware, Lackawanna and Western Railroad Company, the Reading Coal Trestle, and the Grand Trunk Railroad inspected the lines and had no objection to them. A representative of the city park commission inspected and approved the lines. The owners of the water-front property which would be affected by the lines acquiesced in the propriety of the lines being drawn as proposed.

The only objection to the lines came from a man named Howard Winship, who claims to have title to some of the land under water outside of the proposed harbor lines. He was requested to state his objections in writing, which he did, and his protest[1] is herewith. In order that his protest may be understood, a blue print[1] is sent, on which is indicated in red the areas which he claims to own. The land under water back of the dotted line, marked "shore line of Lake Erie in 1816," has all been divided up and is understood to be owned by individuals under more or less cloudy titles. No one has made any objections except Mr. Winship, and I can not believe that his protest should avail against the general public interests.

Upon the tracing which is submitted now a slight change has been made in the harbor line as first proposed by cutting off the projected angle at the foot of Porter avenue. This will make a better entrance to Black Rock Harbor than the original line as proposed if this should ever become an important highway of commerce.

I would therefore recommend that the line as laid down upon the tracing be approved.

A new description of the line is made in consequence of the change and is herewith, and it is requested that the old description, which is also returned, may be destroyed or canceled. In making this description the lines and angles are stated as accurately as practicable. It is endeavored in all cases where possible to make the changes of direction at points which are fixed by intersections or by well-determined distances on known lines. It is deemed proper and justifiable to describe the distances along this harbor line which are in water and which lie between fixed points as "more or less."

Very respectfully, your obedient servant,

T. W. SYMONS,
Major, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

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[1] Not printed.

DESCRIPTION OF HARBOR LINES FOR ERIE BASIN AND BLACK ROCK HARBOR, BUFFALO, N. Y.

Beginning at a point on the south face of the United States Government north pier 1,125 feet westerly from the intersection of said south face with the westerly line of Evans Slip, measured along south face of said United States Government north pier, said point of beginning being also the point of intersection of the line along said south face and a line at right angles to the base line established on the United States Government south pier, 715.6 feet westerly from station zero on said base line;

Thence northeasterly in a straight line 900 feet, more or less, to the point of intersection of the existing easterly dock line of the Erie Basin and the existing southerly dock line of slip No. 1, said point being also 740 feet westerly of the center line of River street measured along the southerly line of said slip No. 1;

Thence northerly on an inclination to the west and in a straight line 990 feet, more or less, to the point of intersection of existing easterly dock line of the Erie Basin with the center line of Genesee street, said point being also 352 feet westerly of the center line of River street, measured on the center line of Genesee street;

Thence northwesterly on an inclination to the west and in a straight line 760 feet, more or less, to the point of intersection of the existing easterly dock line of the Erie Basin with the southerly line of Wilkeson street extended, said point being also 280 feet westerly of the center line of Rock street, measured on said south line of Wilkeson street extended.

Thence westerly approximately at right angles with the last-described harbor line in a straight line 260 feet, more or less, to the southwest corner of the existing Reading coal-trestle dock;

Thence westerly on an inclination to the north and at right angles to the easterly face of the existing Reading coal-trestle dock in a straight line 200 feet to the westerly face of the Reading coal trestle protection jetty;

Thence northerly on an inclination to the north and in a straight line 2,650 feet, more or less, to the intersection of a line 700 feet easterly from and parallel with the easterly face of Bird Island pier and the center line of Maryland street extended, said point of intersection being also 1,420 feet, more or less, westerly from the center line of Fourth street, measured on the center line of Maryland street extended;

Thence northerly on an inclination to the west in a straight line 700 feet easterly from and parallel with the easterly face of Bird Island pier, 2,120 feet, more or less, to the point of intersection of said line and the center line of Jersey street extended, said point being also 2,500 feet, more or less, west of the west line of Front avenue, measured on said center line of Jersey street extended;

Thence northerly on an inclination to the east in a straight line 760 feet, more or less, to a point in the north line of Porter avenue extended, 2,340 feet west of the west line of Front avenue, measured on the said north line of Porter avenue extended;

Thence northerly on an inclination to the east in a straight line 750 feet, more or less, to a point in the north line of Connecticut street extended 1,990 feet west of the west line of Front avenue, measured on the said north line of Connecticut street extended;

Thence northerly on an inclination to the east in a straight line 925 feet, more or less, to a point in the north line of Vermont street extended 1,380 feet west of the west line of Front avenue, measured on the said north line of Vermont street extended;

Thence northerly on an inclination to the west in a straight line 500 feet, more or less, to the westerly face at the existing end of the stone-faced embankment forming the easterly bounds of Black Rock Harbor at this point, and also forming the heel path of the Erie Canal.

Also, beginning at the southeast corner of the New York State breakwater, said point being 380 feet northerly in a straight line at right angles from station 9+69 on the base line established on the United States Government south pier;

Thence northerly in a straight line and parallel with the proposed harbor line on the easterly side of the Erie Basin at this point 450 feet, more or less, to the southerly line of slip No. 1 extended;

Thence on an inclination to the west and in a straight line 1,040 feet, more or less, to a point in the center line of Genesee street extended 732 feet westerly from the center line of River street, measured on said center line of Genesee street;

Thence northerly on an inclination to the west and in a straight line parallel with the proposed harbor line on the easterly side of the Erie Basin at this point 350 feet.

Thence northwesterly on an inclination to the west and in a straight line 660 feet, more or less, to the angle in the easterly face of the New York State breakwater, 200 feet from the existing northeast corner of said breakwater;

Thence along said easterly face of the New York State breakwater 200 feet to the existing northeast corner of said breakwater.

APPENDIX S S.

IMPROVEMENT OF HARBORS ON LAKE ONTARIO AND OF ST. LAWRENCE RIVER AND HARBORS THEREON, NEW YORK.

REPORT FOR THE FISCAL YEAR ENDING JUNE 30, 1901, WITH OTHER DOCUMENTS RELATING TO THE WORKS. OFFICERS IN CHARGE, CAPT. GRAHAM D. FITCH AND MAJ. T. W. SYMONS, CORPS OF ENGINEERS.

IMPROVEMENTS.

1. Wilson Harbor, New York.
2. Charlotte Harbor, New York.
3. Pultneyville Harbor, New York.
4. Harbor at Great Sodus Bay, New York.
5. Harbor at Little Sodus Bay, New York.
6. Oswego Harbor, New York.
7. Harbor at Cape Vincent, New York.
8. Shoals in St. Lawrence River between Ogdensburg and foot of Lake Ontario.
9. Ogdensburg Harbor, New York.

EXAMINATIONS AND SURVEYS.

10. Grasse River, New York.
11. St. Lawrence River at head of Long Sault Island, New York.

United States Engineer Office,
Buffalo, N. Y., July 11, 1901.

General: I have the honor to forward herewith annual reports of operations * * * on the works under my charge for the year ending June 30, 1901. * * *

Very respectfully, your obedient servant,

T. W. Symons,
Major, Corps of Engineers.

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. A.

S S 1.

IMPROVEMENT OF WILSON HARBOR, NEW YORK.

ORIGINAL CONDITION.

This harbor is at the mouth of Twelve-mile Creek. In its original condition there was a depth on the bar of 1 foot. In 1846 two piers were built, by private enterprise, about 400 feet into the lake.

PROJECT FOR IMPROVEMENT.

The original project of 1873 was to extend the piers to the 12-foot curve in Lake Ontario and to dredge a channel 12 feet deep between the piers and to deep water in the creek, at an estimated cost of $90,000, increased in 1877 to $100,000. January 10, 1900, the project was modified to obtain and maintain a depth of 10 feet at extreme low water, without further extension of the piers, at least for the present.

A map of the harbor faces page 2398 of the annual report for 1889.

Dredging to the depth called for by the project has been completed, and the west and east piers have been extended to 832 and 850 feet, respectively. The west pier is now 225 feet and the east pier 325 feet from the 12-foot curve in Lake Ontario, the limit for pier construction specified in the project.

The total amount expended on this harbor to June 30, 1900, was $71,793.19, of which $57,387.45 was for construction and $14,405.74 for maintenance. The amount expended during the year ending June 30, 1901, was $707.31.

REPORT OF OPERATIONS.

The closing of a hole under two cribs in the west pier, by driving 44 linear feet of Wakefield sheet piling, and the making of the most necessary repairs to the decking of both piers, commenced in the preceding fiscal year, was completed in July, 1900.

REMARKS.

The channel between the piers is not stable, filling rapidly with sand driven by storms.

ESTIMATE.

If this harbor is to be maintained by the Government there will be required to June 30, 1903, to do the work necessary to keep the channel open, $3,000.

The commerce of Wilson Harbor by water is small, but considerable numbers of visitors are brought into it by excursion steamers during the summer season, the number in 1900 being 4,555.

It is suggested that, owing to the insignificance of this port and its commerce, it might well be abandoned as a port to be maintained by the United States.

Money statement.

July 1, 1900, balance unexpended	$707.31
June 30, 1901, amount expended during fiscal year	707.31
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement	3,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

Appropriations.

Date.	Amount.	Aggregate.
March 3, 1875	$10,000.00	$10,000.00
August 14, 1876	10,000.00	20,000.00
June 14, 1880	10,000.00	30,000.00
March 3, 1881	10,000.00	40,000.00
August 2, 1882	10,000.00	50,000.00
August 5, 1886	10,000.00	60,000.00
August 11, 1888	5,000.00	65,000.00
June 3, 1896	5,000.00	70,000.00
May 12, 1897	.50	70,000.50
March 3, 1899	2,500.00	72,500.50

COMMERCIAL STATISTICS.

Class of goods.	Net tons.
Lumber	474
Logs	138
Shingles	24
Lath	17
Total	653

Increase over last year, 529 tons.
Number of passengers carried, 4,555.
Increase in number of passengers carried over last year, 1,549.

S S 2.

IMPROVEMENT OF HARBOR AT CHARLOTTE, NEW YORK.

ORIGINAL CONDITION.

This harbor is at the mouth of the Genesee River. In its original condition vessels could carry only 8 feet across the bar.

PROJECT FOR IMPROVEMENT.

The original project of 1829 was to scour a channel 12 feet deep across the bay by constructing parallel piers to confine and direct the action of spring freshets in the Genesee River. The present project of 1882 is to obtain a depth of 15 feet by extending the two peirs a total of 3,250 feet and by dredging. After the piers had been extended 1,444 feet the project was modified July 18, 1896, to preserve the depth by dredging without further extension of the piers for the present, and March 2, 1897, it was again modified to obtain and maintain not less than 16 feet and not more than 16½ feet at extreme low water.

The total amount expended on this improvement to June 30, 1900, was $527,770.42. It is impracticable to separate the cost of construction and maintenance. The amount expended during the fiscal year 1901 was $2,109.35, all for maintenance.

REPORT OF OPERATIONS.

UNDER REGULAR APPROPRIATION.

The dredging and pier repairs done in the fiscal year ending June 30, 1900, exhausted the $7,000 appropriated by the river and harbor act of March 3, 1899, except a small balance which was retained to pay for gauge reading and watching.

The condition of the piers was examined in December, 1900, and the water gauge read tridaily during the year.

UNDER ALLOTMENTS FROM EMERGENCIES IN RIVER AND HARBOR WORKS.

August 4, 1900, an allotment of $1,000 was made by the Secretary of War for placing stone in depleted pockets in the west and east piers at Charlotte. The work was done in September and October, 1900, 144¾ cords of stone being distributed where most needed in both piers.

April 26, 1901, the steamer *Hecla*, which carries coal from Charlotte to Ogdensburg, N. Y., in coming out of Charlotte Harbor, drawing 15 feet, began to touch bottom near station 18. After dragging a few hundred feet the vessel lost steerageway and went hard aground near the west pier. It was necessary to employ the services of a tug to pull the steamer off. The stage of water was 2.3 feet above extreme low water, so that when the *Hecla* grounded the channel must have shoaled to nearly 12 feet below extreme low water.

To afford navigation the needed relief the Secretary of War, May 24, 1901, allotted the sum of $2,500 from the appropriation of $250,000 provided by the act of June 6, 1900, for "Emergencies in river and harbor works," to be applied to dredging to restore the channel depth in the entrance to Charlotte Harbor.

The United States dredging plant, which was at work in Oswego Harbor removing part of the upper island in the river there, was thereupon transferred to Charlotte and began dredging May 21. To June 30, 1901, 14,790 cubic yards of material had been removed.

REMARKS.

The channel, which is 3,700 feet in length from the harbor to the 16-foot curve in the lake, requires more or less redredging annually on account of sediment deposited by the Genesee River in freshets. Besides dredging, there are 5,100 feet of piers still requiring maintenance by the Government. These piers are in need of extensive repairs.

The Genesee River when in flood carries a large quantity of detritus in suspension; above the bridge it has a velocity of about 2¾ miles per hour. The river at this point of its course is 330 feet wide, with 200 feet between the 18-foot curves, and has a total cross section at zero of gauge of about 5,400 square feet.

The width between the piers is about 475 feet, and the cross section as calculated from the survey of December, 1899, is 6,400 square feet. In consequence of the increased cross section the velocity of the current when in flood as above is reduced near the east pier to about 2 miles per hour, while near the west pier it is much less, with the result that the heavy matter carried in suspension is deposited between the piers.

A channel of navigable depth between the piers for the deepest-draft boats using it is only obtained by dredging, which must be done practically every year to maintain it. For the last six fiscal years the cost has been approximately $3,700 per year.

A study of the various surveys from 1894 to December, 1899, shows a constant deposition of material between the piers, the greatest amount of which has been in the dredged channel, usually made from 125 to 200 feet wide. There has, however, been a decided decrease in the depths at the sides of the channel, especially on the west, where the 12 and 14 foot curves on the different charts show a steady filling.

It is evident that the stream is attempting to set up the same conditions below the bridge which exist above it, in which it is being constantly thwarted by the dredging which is being carried on.

It is respectfully submitted that the efforts of the stream might be aided by reducing its cross section and maintaining the current at or near the same velocity as above the bridge far enough out so that the suspended material may be carried beyond the ends of the piers a sufficient distance to be carried away by the littoral drift in the lake, which is from the west.

It is recommended that a mattress be laid lengthwise of the channel between the piers, to be sunk with stone, the mattress and stone to be of such thickness as to leave the top of the stone not higher than 7 feet below extreme low water (7.7 feet below zero). The laying of the mattress should be carried on at the same time that the dredging of the channel takes place, and the dredged material should be placed between the mattress and the west pier.

The mattress could be sunk with small stone as far out as station 26, but from that point it will probably be necessary to use large and heavy stone, as they would be acted upon by the seas occasioned by the northeast gales, which sweep directly into the channel between the piers.

It is estimated that the cost of the above work would be:

For mattress 3,600 feet long, 12 feet wide, 4,800 square yards, at $1.25 per yard	$6,000
For stone for sinking and holding mattress, 4,500 cubic yards, at $1.50 per yard	6,750
	12,750
Add 20 per cent for contingencies, superintendence, engineering, etc	2,550
Say $15,000.	15,300

The channel should be dredged 150 feet wide and 16 feet deep at extreme low water, giving a cross section of about 5,000 square feet, somewhat less than that of the stream above the bridge.

This arrangement would leave the entire width of the channel to take care of extreme flood discharge, and if successful, as it is believed it would be, would provide a wider and deeper channel than it has been found possible to maintain by dredging.

The above statement of the conditions at Charlotte Harbor and project for contracting the channel between the piers there are submitted by authority of the Chief of Engineers ($\frac{7694}{31}$) of June 3, 1901.

It is estimated that there will be required to June 30, 1903:

For improvement:		
For 3,600 feet of mattress in place complete		$15,000
For maintenance:		
For redredging, engineering and office expenses and incidentals	$7,500	
For repairs to piers	7,500	
		15,000
Total		30,000

The total commerce at this port during the calendar year ending December 31, 1900, was 399,605 tons, of which 397,032 tons were coal, brought by rail from mines in Pennsylvania to Charlotte, 77.7 per cent of which was shipped down the St. Lawrence River, 20.4 per cent to Canadian ports on Lake Ontario, and 1.9 per cent through the Welland Canal. A strike among the coal miners, lasting for six weeks, during the busiest coal-shipping period and a long continuance of unfavorable weather in the latter part of the season interfered largely with the commerce of this port in 1900.

Money statement.

July 1, 1900, balance unexpended		$557.98
Amount allotted August 4, 1900	$1,000.00	
Amount allotted May 24, 1901	2,500.00	
		3,500.00
		4,057.98
June 30, 1901, amount expended during fiscal year		2,109.35
July 1, 1901, balance unexpended		1,948.63
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement, in addition to the balance unexpended July 1, 1901		30,000.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

Appropriations.

Date.	Amount.	Aggregate.	Date.	Amount.	Aggregate.
May 23, 1828	$300.00	$300.00	July 11, 1870	$12,000.00	$293,578.40
March 2, 1829	10,000.00	10,300.00	March 3, 1871	10,000.00	303,578.40
March 3, 1829	13,335.00	23,635.00	March 3, 1875	5,000.00	308,578.40
March 2, 1831	16,670.00	40,305.00	June 18, 1878	1,000.00	309,578.40
February 24, 1832	16,000.00	56,305.00	March 3, 1879	1,000.00	310,578.40
March 2, 1833	15,000.00	71,305.00	June 14, 1880	5,000.00	315,578.40
June 28, 1834	20,000.00	91,305.00	March 3, 1881	2,500.00	318,078.40
March 3, 1835	2,390.00	93,695.00	August 2, 1882	35,000.00	353,078.40
July 2, 1836	20,000.00	113,695.00	July 5, 1884	20,000.00	373,078.40
March 3, 1837	10,000.00	123,695.00	August 5, 1886	26,250.00	399,328.40
July 7, 1838	25,000.00	148,695.00	August 10, 1888	45,000.00	444,328.40
June 11, 1844	10,000.00	158,695.00	September 19, 1890	25,000.00	469,328.40
August 20, 1852	20,000.00	178,695.00	July 13, 1892	25,000.00	494,328.40
March 3, 1853	176.10	178,871.10	August 18, 1894	15,000.00	509,328.40
June 28, 1864	25,000.00	203,871.10	June 3, 1896	12,000.00	521,328.40
June 23, 1866	75,607.30	279,478.40	March 3, 1899	7,000.00	528,328.40
July 25, 1868	1,100.00	280,578.40	June 6, 1900 *b*	3,500.00	531,828.40
April 10, 1869 *a*	1,000.00	281,578.40			

a Allotments.

b Unexpended balance of $41.24 turned into Treasury.

COMMERCIAL STATISTICS.

Class of goods.	Net tons.
Coal	397,032
Poles and railroad ties	1,115
Lumber	585
Posts and wood	513
Oil	96
Shingles	14
General merchandise	250
Total	~~399~~,605 39[illegible],

Decrease since last year, 47,823 tons.

NOTE.—The decrease in the shipment of coal is attributable to a strike of coal miners which lasted for six weeks during the busiest shipping season.

Number of passengers carried, 73,548.

Increase in number of passengers over 1899, 20,059.

Navigation opened April 20 and closed December 9, 1900.

Statement of vessels at Charlotte Harbor, New York, for the calendar year ending December 31, 1900.

ARRIVALS.

Trade engaged in.	Steamers.		Sailing vessels.		Barges.	
	Number.	Registered tonnage.	Number.	Registered tonnage.	Number.	Registered tonnage.
Home	619	127,687	13	2,938	51	17,674
Foreign	533	301,454	140	34,308	159	70,203
Total	1,152	429,141	153	37,246	210	87,877
American owned	624	122,600	33	10,622	89	32,292
Canadian owned	528	306,541	120	26,624	121	55,585

Total arrivals, 1,515; registered tonnage, 554,264.

DEPARTURES.

Trade engaged in.	Steamers.		Sailing vessels.		Barges.	
	Number.	Registered tonnage.	Number.	Registered tonnage.	Number.	Registered tonnage.
Home	646	147,918	2	691	23	7,562
Foreign	506	281,223	151	36,555	187	80,315
Total	1,152	429,141	153	37,246	210	87,877

Total departures, 1,515; registered tonnage, 554,264.
Greatest draft of vessel, 15.5 feet.
Greatest tonnage of vessel, registered tonnage, 1,651.
Greatest load of vessel, net tons, 1,675.

S S 3.

IMPROVEMENT OF HARBOR AT PULTNEYVILLE, NEW YORK.

ORIGINAL CONDITION.

This harbor is at the mouth of Salmon Creek. In its original condition there was, at extreme low water, a depth of only about 20 inches in the cove and mouth of the creek. A pier 171 feet long had been built by private enterprise on the north side of the mouth of the creek.

PROJECT FOR IMPROVEMENT.

The original project of 1871–72 was to protect the approach to the creek by building two piers in the lake of timber cribs filled with stone, and to dredge a channel 10 feet deep from the 10-foot curve in Lake Ontario to the mouth of the creek, at an estimated cost of $59,000, increased in 1875 to $71,000 on account of the difficult character of the dredging.

A plan of the harbor faces page 2462 of the Annual Report of the Chief of Engineers for 1894.

The total amount expended on this harbor to June 30, 1900, was $78,263.61, of which $70,607.96 was for construction and $7,655.65 for maintenance. The amount expended during the year ending June 30, 1901, was $736.39.

REPORT OF OPERATIONS.

The United States dredging plant commenced work July 1, and to July 12, 1900, when work was suspended on account of depletion of funds, 3,390 cubic yards of sand and gravel were dredged from a cut 960 feet long, 20 feet wide, and 8 feet deep below extreme low water.

REMARKS.

Pultneyville is a village of some 300 inhabitants with an insignificant commerce by water. The channel is very unstable, rapidly filling with sand and gravel. In the annual report for 1895, page 420, the channel depth is reported as "about 10 feet at low water in the lake;" in July, 1896, it was 6 feet, and in October, 1896, the depth at low water was barely 4 feet. In March, 1899, the depth was three-tenths of a foot at extreme low water.

No money is asked for for this harbor, and it is recommended that it be abandoned as a harbor to be maintained by the United States.

Money statement.

July 1, 1900, balance unexpended	$736.39
June 30, 1901, amount expended during fiscal year	736.39

Appropriations.

Date.	Amount.	Aggregate.	Date.	Amount.	Aggregate.
July 11, 1870	$5,000	$5,000	June 14, 1880	$3,000	$65,000
March 3, 1871	5,000	10,000	March 3, 1881	2,000	67,000
June 10, 1872	10,000	20,000	August 2, 1882	4,000	71,000
March 3, 1873	10,000	30,000	September 19, 1890	2,000	73,000
June 23, 1874	10,000	40,000	July 13, 1892	1,000	74,000
March 3, 1875	10,000	50,000	August 18, 1894	1,500	75,500
August 14, 1876	3,000	53,000	June 3, 1896	1,[illegible]	77,000
June 18, 1878	5,000	58,000	March 3, 1899	2,000	79,000
March 3, 1879	4,000	62,000			

COMMERCIAL STATISTICS.

Class of goods.	Net tons.
Posts and wood	152
Brick	63
Shingles	24
Lath	8
Total	247

Number of passengers carried, 60.

S S 4.

IMPROVEMENT OF HARBOR AT GREAT SODUS BAY, NEW YORK.

ORIGINAL CONDITION.

In its original condition the channel connecting this bay with Lake Ontario was wide, and impracticable for vessels drawing over 8 feet.

PROJECT FOR IMPROVEMENT.

The original project of 1829 was to narrow the entrance by constructing two converging breakwaters, and to deepen it to 12 feet by building two parallel piers and by dredging. The present project of 1882 is to obtain a depth of 15 feet at extreme low water by extending the two piers a total length of 1,100 feet and by dredging. After the piers had been extended 519 feet the project was modified July 18, 1896, to restore and maintain the requisite depth of 15 feet by dredging, without further extension of the piers for the present.

The total amount expended on this improvement to June 30, 1900, was $483,037.30, of which $408,251.80 was for construction and $74,785.50 for maintenance. The amount expended during the fiscal year ending June 30, 1901, was $3,598.54.

REPORT OF OPERATIONS.

Work with the United States plant commenced July 16, 1900, and continued to October 15, 1900, when the plant was transferred to Little Sodus. During that time 21,602 cubic yards of sand were dredged from the channel between the piers to 15 feet below extreme low water.

The harbor was surveyed in July, 1900, and repairs were made to the dredge and two scows during the winter of 1900–1901.

REMARKS.

The channel between the piers is 1,800 feet long from the bay to the 15-foot curve in Lake Ontario, and requires more or less redredging annually on account of shoaling, chiefly caused by the drifting of sand from the west. Besides the maintenance of the channel there are 2,150 feet of breakwater and 2,894 feet of piers to be maintained.

It is estimated that there will be required to June 30, 1903—

For dredging, engineering, office expenses, surveys, and superintendence	$7,500
For repairs to piers	2,500
Total	10,000

The total commerce of this port for the calendar year ending December 31, 1900, was 84,379 tons, of which 82,260 tons were coal, 74.9 per cent of which was shipped to Canadian ports on Lake Ontario and 25.1 per cent down the St. Lawrence River.

Money statement.

July 1, 1900, balance unexpended	$6,610.50
June 30, 1901, amount expended during fiscal year	3,598.54
July 1, 1901, balance unexpended	3,011.96
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement, in addition to the balance unexpended July 1, 1901 Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	10,000.00

Appropriations.

Date.	Amount.	Aggregate.	Date.	Amount.	Aggregate.
May 23, 1828 (survey)	$400.00	$400.00	June 23, 1874	$15,000.00	$321,771.80
March 2, 1829	12,500.00	12,500.00	March 3, 1875	10,000.00	331,771.80
March 3, 1829	15,280.00	27,780.00	August 14, 1876	5,000.00	336,771.80
March 2, 1831	17,450.00	45,230.00	June 18, 1878	5,000.00	341,771.80
February 24, 1832	17,000.00	62,230.00	March 3, 1879	2,000.00	343,771.80
March 2, 1833	15,000.00	77,230.00	June 14, 1880	3,000.00	346,771.80
June 28, 1834	15,000.00	92,230.00	March 3, 1881	5,000.00	351,771.80
March 3, 1835	11,790.00	104,020.00	August 2, 1882	25,000.00	376,771.80
July 2, 1836	12,600.00	116,620.00	July 5, 1884	10,000.00	386,771.80
March 3, 1837	12,000.00	128,620.00	August 5, 1886	16,875.00	403,646.80
July 7, 1838	10,000.00	138,620.00	August 10, 1888	24,000.00	427,646.80
June 11, 1844	5,000.00	143,620.00	September 19, 1890	10,000.00	437,646.80
August 20, 1852	10,000.00	153,620.00	July 13, 1892	15,000.00	452,646.80
June 23, 1866	53,151.80	206,771.80	August 18, 1894	15,000.00	467,646.80
March 2, 1867	80,000.00	286,771.80	June 3, 1896	8,000.00	475,646.80
July 11, 1870	5,000.00	291,771.80	March 3, 1899	14,000.00	489,646.80
June 10, 1872	15,000.00	306,771.80	July, 1899 (repayment	1.00	489,647.80

COMMERCIAL STATISTICS.

Class of goods.	Net tons.
Coal	82,260
Poles and railroad ties	1,462
Posts and wood	284½
Lumber	224
Fish	3¼
General merchandise	145¼
Total	84,379

Increase over last year, 5,494 tons.
Number of passengers carried, 4,491.
Increase in number of passengers carried over 1899, 1,881.
Navigation opened April 25 and closed December 1, 1900.

Statement of vessels at Great Sodus Harbor, New York, during the calendar year ending December 31, 1900.

ARRIVALS.

Trade engaged in.	Steamers.		Sailing vessels.		Barges.	
	Number.	Registered tonnage.	Number.	Registered tonnage.	Number.	Registered tonnage.
Home	98	20,876	12	1,942	41	13,935
Foreign	37	4,721	59	8,719	29	9,559
Total	135	25,597	71	10,661	70	23,494
American owned	96	20,499	15	2,656	36	10,598
Canadian owned	39	5,098	56	8,005	34	12,896

Total arrivals, 276; registered tonnage, 59,752 tons.

DEPARTURES.

Trade engaged in.	Steamers.		Sailing vessels.		Barges.	
	Number.	Registered tonnage.	Number.	Registered tonnage.	Number.	Registered tonnage.
Home	97	20,750	12	1,848	26	8,004
Foreign	37	4,796	60	8,827	44	15,490
Total	134	25,546	72	10,675	70	23,494

Total departures, 276; registered tonnage, 59,715 tons.
Greatest draft of vessel, 12 feet.
Greatest tonnage of vessel, registered tonnage, 541.
Greatest load of vessel, net tons, 1,260.

S S 5.

IMPROVEMENT OF HARBOR AT LITTLE SODUS BAY, NEW YORK.

ORIGINAL CONDITION.

In its original condition the channel connecting this bay with Lake Ontario was about 150 feet wide and 18 inches deep.

PROJECT FOR IMPROVEMENT.

The original project of 1854 was to deepen the channel by building two parallel piers across the bar to the 15-foot curve in Lake Ontario and to connect them with the shore by riprap. In 1867 this project was modified to provide for dredging to the depth of 12 feet. The present project, of 1882, is to obtain a depth of 15 feet by extending the piers to the 15-foot curve in the lake and by dredging. After the piers had been extended an aggregate length of 835 feet the project was modified in 1898 to restore and maintain the requisite depth of 15 feet at extreme low water by dredging without further extension of the piers for the present.

The total amount expended on this improvement to June 30, 1900, was $335,722.51, of which $280,448.26 was for construction and $55,274.25 for maintenance. The total amount expended during the fiscal year ending June 30, 1901, was $1,646.18.

REPORT OF OPERATIONS.

Work with the United States plant commenced October 21, 1900, and continued to November 13, 1900, when the plant was transferred to Oswego. During that time 7,950 cubic yards of sand were dredged from the channel between the piers, making a channel 60 feet wide and 13.2 feet deep at extreme low water.

REMARKS.

The entrance channel is 2,300 feet in length from the bay to the 15-foot curve in the lake. It requires more or less redredging annually on account of shoaling caused chiefly by the drifting of sand from the west.

Besides the maintenance of this channel there are 4,964 feet of piers and breakwaters to be maintained, viz, the west pier, 1,747 feet; the east pier, 1,510 feet, and the east breakwater, 1,664 feet. The west breakwater is entirely covered by accretion of sand. The piers are much in need of repairs.

It is estimated that there will be required to June 30, 1903:

For dredging, office expenses, surveys, and superintendence	$3,500
For repairs to piers	5,000
Total	8,500

The total commerce of this port during the calendar year ending December 31, 1900, was 59,511 tons, of which 52,200 tons were coal, 52.2 per cent of which was shipped down the St. Lawrence River and

47.8 per cent to Canadian ports on Lake Ontario. A strike of coal miners, lasting for six weeks during the busiest shipping season in the fall of 1900, accounts for the decrease in commerce during the year.

It is believed that a depth of 15 feet at extreme low water in a channel of proper and sufficient width can be maintained in the entrance channel by dredging any material that can be deposited therein. But there seems to be a necessity for extending the east pier out as far or nearly as far as the west pier, and the following estimate is presented for extension of the east pier a distance of 300 feet:

Estimated cost.

Substructure:	
Preparing bottom	$1,000
Hemlock timber cribs filled with stone, 12 feet high by 24 feet wide, 300 linear feet, at $35 per foot	10,500
Superstructure:	
Heavy capping stone, 5¼ cubic yards, equal to 11 tons per linear foot; total for 300 linear feet, 3,300 tons, at $2 per ton	6,600
	18,100
Contingencies, engineering and office expenses, 10 per cent	1,810
Total	19,910

In round numbers, $20,000.

Money statement.

July 1, 1900, balance unexpended	$2,720.26
June 30, 1901, amount expended during fiscal year	1,646.18
July 1, 1901, balance unexpended	1,074.08
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement, in addition to the balance unexpended July 1, 1901 Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	8,500.00

Appropriations.

Date.	Amount.	Aggregate.	Date.	Amount.	Aggregate.
August 30, 1852	$10,000.00	$10,000.00	June 18, 1878	$10,000.00	$189,441.77
April 9, 1864	1,178.36	11,778.36	March 3, 1879	5,000.00	194,441.77
Do	2,224.00	14,002.36	June 14, 1880	20,000.00	214,441.77
Do	99.00	14,101.36	March 3, 1881	20,000.00	234,441.77
June 23, 1866	33,840.41	47,941.77	August 2, 1882	25,000.00	259,441.77
March 2, 1867	50,000.00	97,941.77	July 5, 1884	10,000.00	269,441.77
April 10, 1869	1,500.00	99,441.77	August 5, 1886	12,500.00	281,941.77
July 11, 1870	5,000.00	104,441.77	August 10, 1888	16,000.00	297,941.77
March 3, 1871	15,000.00	119,441.77	September 19, 1890	13,000.00	310,941.77
June 10, 1872	15,000.00	134,441.77	July 13, 1892	6,000.00	316,941.77
March 3, 1873	15,000.00	149,441.77	August 18, 1894	8,000.00	324,941.77
June 23, 1874	15,000.00	164,441.77	June 3, 1896	8,000.00	332,941.77
March 3, 1875	10,000.00	174,441.77	March 3, 1899	5,500.00	338,441.77
August 14, 1876	5,000.00	179,441.77	July, 1899 (repayment)	1.00	338,442.77

COMMERCIAL STATISTICS.

Class of goods.	Net tons.
Coal	52,200
Poles and railroad ties	6,494
Posts and wood	812½
Fish	4½
Total	59,511

Decrease since last year, 22,458 tons.

NOTE.—The decrease in the shipment of coal is attributable to a strike of coal miners, which lasted for six weeks during the busiest period of shipping.

Navigation opened April 18 and closed December 3, 1900.

Number of passengers carried, 1,398.

One transportation line established, the Lake Ontario and St. Lawrence River Day Line.

Statement of vessels at Little Sodus Harbor, New York, for the calendar year ending December 31, 1900.

ARRIVALS.

Trade engaged in.	Steamers.		Sailing vessels.		Barges.	
	Number.	Registered tonnage.	Number.	Registered tonnage.	Number.	Registered tonnage.
Home	60	11,059	12	1,467	24	8,128
Foreign	31	3,352	66	11,060	15	5,729
Total	91	14,411	78	12,527	39	13,857
American owned	49	10,582	7	364	12	3,755
Canadian owned	42	3,829	71	12,163	27	10,102

Total arrivals, 208; registered tonnage, 40,795.

DEPARTURES.

Trade engaged in.	Steamers. Number.	Steamers. Registered tonnage.	Sailing vessels. Number.	Sailing vessels. Registered tonnage.	Barges. Number.	Barges. Registered tonnage.
Home	58	10,915	10	1,293	7	2,290
Foreign	33	3,496	68	11,234	32	11,567
Total	91	14,411	78	12,527	39	13,857

Total departures, 208; registered tonnage, 40,795.

Greatest draft of vessel	feet	13
Greatest tonnage of vessel	registered tonnage	541
Greatest load of vessel	net tons	1,299

S S 6.

IMPROVEMENT OF HARBOR AT OSWEGO, NEW YORK.

ORIGINAL CONDITION.

In its original condition this harbor, consisting of an inner part in the Oswego River, which was navigable by vessels of light draft only, and of an outer part, forming a cove in the lake, had no protection against the seas.

PROJECT FOR IMPROVEMENT.

The original project of 1827 (completed in 1829) was to build across the cove a breakwater of timber cribs filled with stones. Between 1830 and 1838 a superstructure of masonry was built on 500 feet of the breakwater. Between 1866 and 1869 $41,000 was expended in dredging the harbor to the depth of 12 feet at extreme low water. Between 1868 and 1870 the light-house pier was extended north 437 feet. In 1881 an outer breakwater was completed having a lake face 4,870 feet long, a westerly shore return 916 feet long, and an easterly return 246 feet long. In 1881 a project was adopted to build an east breakwater, 248 feet of which was constructed in 1881 and removed in 1889. In 1885 and 1889 two spurs to the outer breakwater, 100 feet and 150 feet long, were completed. In 1893 the excavation of rock in the river was added to the project,

The present project of 1896, as subsequently modified, is:

First. To build an east breakwater 1,435 feet long, at an estimated cost of $197,000.

Second. To narrow the breach made in the outer breakwater in 1884 from 175 feet to about 75 feet, at an estimated cost of $18,500.

Third. To carry the rock excavation in the Oswego River farther upstream.

Fourth. To remove part of the island between Schuyler and Van Buren streets to a depth of 15 feet; also to excavate rock and dredge to a small extent between the island and the west bank, at an estimated cost of $12,000.

The total amount expended on this improvement to June 30, 1900, was $1,934,208.19. It is impracticable to separate the cost of construction and of maintenance. The total amount expended during the fiscal year ending June 30, 1901, was $27,515.43.

REPORT OF OPERATIONS.

Partially closing 1884 breach.—Authority to reduce this breach from 175 feet to about 75 feet was given by indorsement from the office of the Chief of Engineers of June 20, 1896, but the funds available from the appropriation for this harbor made by act of March 3, 1899, being insufficient for the completion of the work, a 50-foot crib was placed at the west side of the opening.

The preparation of the foundation for the crib was completed in July, the crib itself sunk in place in August, and the work completed in September, 1900. Thirty linear feet of old superstructure immediately west of the new crib was torn out and rebuilt to permit secure bonding.

Removal of part of upper island.—The river and harbor act of March 3, 1899, authorized the removal of 253 feet of the upper (southerly) island in Oswego Harbor to the depth of 15 feet and the excavation of rock and a small amount of dredging between the island and the west bank.

The necessary deeds conveying title to the United States having been granted and approved, the United States dredging plant commenced work November 19, 1900, and continued dredging until February 13, 1901, when work was suspended on account of ice and the plant laid up for the winter. Work was resumed May 9 and temporarily suspended May 16, to allow the plant to proceed to Charlotte to restore the depth in the entrance to that harbor.

Repairs to outer breakwater.—These repairs were begun on May 21 and were continued to the end of the year, under allotment of $10,000 made March 22, 1901.

The incipient breach at station 3+25 has been nearly repaired, and work on another at station 8 has been started.

REMARKS AND ESTIMATE.

The outer breakwater at Oswego, N. Y., is the most important of all the works of improvement there. Excluding the breach made in 1884 (reduced by 50 feet in 1900), its lake face is 4,745 feet long, with two shore returns aggregating 1,162 feet in length. It was built during the period from 1870 to 1882, and is composed of a series of timber cribs, 35 feet square, filled with stone, surmounted by a continuous superstructure, the parapet of which extends to about 13 feet above low water and the banquette to about 5 feet above low water.

This breakwater is a weak structure, inadequate to withstand the forces tending to destroy it. As evidence of its inherent weakness it may be noted that while it was under construction nearly $90,000, or 12½ per cent of the total cost of construction, was spent upon repairs. From 1881, when construction was completed, to June 30, 1901, the cost for maintenance and repairs amounted to $343,000, making, with the $90,000 expended while construction was in progress, the total cost for maintenance and repairs to June 30, 1901, $433,000, or 60 per cent of the total cost of construction.

This breakwater has been breached six times—twice in 1876, and once each in 1882, 1884, 1896, and 1899, all of which have been fully repaired except the 1884 breach, in which a 50-foot crib was placed in 1900, but which is still about 125 feet wide.

Commencing in 1897 yearly examinations of the lake face of the breakwater have been made by divers. The first examination revealed the existence of nine incipient breaches in a belt about 6 feet wide below the water line, and the examination each succeeding year has revealed these incipient breaches in increasing numbers. The examination made in May, 1901, showed that the entire lake faces of two cribs were so much drawn out as to require quite extensive repairs, and besides these there were fourteen cribs whose lake faces were drawn from 3 to 8 inches.

The method of repairing these incipient breaches is to remove the stone in the pockets of the cribs to as great a depth as necessary and fasten vertical posts to the side walls or to the lateral ties with lag screws. Screw bolts are then run through the post and outer wall, the wall is drawn back into place, and the pockets are refilled with stone. This work is necessarily slow and expensive, the cost varying with the depth of the breach.

Not only is the substructure of this breakwater in bad condition and deteriorating rapidly, but the superstructure is also in bad condition, calling for constant care and attention. The timber work of the superstructure along the entire lake arm is badly rotted in places and requires constant patching to keep it intact. The probable life of this part of the superstructure is not more than four years.

The necessity for a general strengthening of both the substructure and superstructure of the Oswego outer breakwater is evident and urgent, and it is to be hoped that Congress will take early action in the matter.

In the Annual Report of the Chief of Engineers for 1899 (pp. 3142–3143) two methods of strengthening the substructure with two varieties of superstructure are given in detail, with estimates of cost. These methods, with estimated costs, are summarized as follows:

1. Heavy riprap protection for substructure and concrete superstructure	$887,700
2. Substructure strengthened with vertical posts and concrete superstructure	677,300
3. Heavy riprap protection for substructure and superstructure of creosoted pine	676,300
4. Substructure strengthened with vertical posts and superstructure of creosoted pine	465,800

It is estimated that there will be required to June 30, 1903:

For improvement:		
Continuing rock excavation in river		$25,000
For maintenance:		
Reducing 1884 breach by 50 feet to 75 feet	$10,000	
Strengthening substructure and renewing superstructure	150,000	
Contingent repairs	10,000	
Engineering, office, and incidental expenses	20,000	
		190,000
Total		215,000

The total commerce at this port during the calendar year ending December 31, 1900, was 575,160 tons, of which 425,641 tons were coal, 50.8 per cent of which was shipped to Canadian ports on Lake Ontario, 40.5 per cent down the St. Lawrence River, and 8.7 per cent through the Welland Canal. A strike among the coal miners, lasting for six weeks during the usually busiest shipping period, and a long continuance of unfavorable weather in the latter part of the season, interfered largely with the trade of this port in 1900.

Money statement.

July 1, 1900, balance unexpended	$28,404.68
Allotted March 22, 1901	10,000.00
	38,404.68
June 30, 1901, amount expended during fiscal year	27,515.43
July 1, 1901, balance unexpended	10,889.25

Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901:		
For works of improvement	$25,000.00	
For maintenance of improvement	190,000.00	
		215,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

Appropriations.

Date.	Amount.	Aggregate.	Date.	Amount.	Aggregate.
March 20, 1826	$200.00	$200.00	April 10, 1869, allotment	$22,275.00	$473,362.87
March 2, 1827	33,348.64	33,548.64	Do	6,000.00	479,362.87
May 19, 1828	9,583.39	43,132.03	July 11, 1870	50,000.00	529,362.87
March 3, 1829	7,472.00	50,604.03	March 3, 1871	100,000.00	629,362.87
March 2, 1831	2,812.92	53,416.95	June 10, 1872	100,000.00	729,362.87
Do	18,600.00	72,016.95	March 3, 1873	100,000.00	829,362.87
Do	519.00	72,535.95	June 23, 1874	75,000.00	904,362.87
Do	84.92	72,620.87	March 3, 1875	90,000.00	994,362.87
February 24, 1832	19,000.00	91,620.87	August 14, 1876	90,000.00	1,084,362.87
March 2, 1833	8,400.00	100,020.87	June 18, 1878	90,000.00	1,174,362.87
June 28, 1834	30,000.00	130,020.87	March 3, 1879	90,000.00	1,264,362.87
July 2, 1836	20,000.00	150,020.87	June 14, 1880	90,000.00	1,354,362.87
March 3, 1837	15,000.00	165,020.87	March 3, 1881	50,000.00	1,404,362.87
July 7, 1838	46,067.00	211,087.87	August 2, 1882	80,000.00	1,484,362.87
June 11, 1844	20,000.00	231,087.87	July 5, 1884	80,000.00	1,564,362.87
August 20, 1852	40,000.00	271,087.87	August 6, 1886	71,250.00	1,635,612.87
August, 1860, allotment transferred from light-house	30,000.00	301,087.87	August 10, 1888	100,000.00	1,735,612.87
			September 19, 1890	30,000.00	1,765,612.87
			July 13, 1892	40,000.00	1,805,612.87
June 28, 1864, allotment	25,000.00	326,087.87	August 18, 1894	37,000.00	1,842,612.87
June 23, 1866	45,000.00	371,087.87	June 3, 1896	60,000.00	1,902,612.87
March 2, 1867	60,000.00	431,087.87	March 3, 1899	60,000.00	1,962,612.87
July 25, 1868, allotment	20,000.00	451,087.87	June 6, 1900, allotment	10,000.00	1,972,612.87

COMMERCIAL STATISTICS.

Class of goods.	Net tons.	Class of goods.	Net tons.
Coal	425,641	Ashes	269
Lumber	69,216	Hay	67
Grain	11,231	Fish	30
Poles and railroad ties	3,667	General merchandise	2,287
Shingles	3,361	Freight entering and leaving Oswego by canal	56,487
Posts and wood	919		
Lath	917		
Sand and clay	797	Total	579,160
Talc	271		

Decrease since last year, 141,593 tons.

NOTE.—The decrease is largely in the quantity of coal shipped, attributable to a strike of coal miners, which lasted for six weeks during the busiest part of the shipping season.

Number of passengers carried, 8,712.

Decrease in number of passengers carried, 1,427.

Navigation opened April 2 and closed December 10, 1900.

Statement of vessels at Oswego Harbor, New York, for the calendar year ending December 31, 1900.

ARRIVALS.

Trade engaged in.	Steamers.		Sailing vessels.		Barges.	
	Number.	Registered tonnage.	Number.	Registered tonnage.	Number.	Registered tonnage.
Home, on lake	197	40,817	79	9,793	110	39,277
Foreign, on lake	355	64,855	406	78,625	156	49,272
Total	552	105,672	485	88,418	266	88,549
American owned	278	55,322	90	13,462	87	27,567
Canadian owned	274	50,350	395	74,956	179	60,982

Total arrivals, 1,303; registered tonnage, 282,639.

Statement of vessels in Oswego Harbor, New York, for the calendar year ending December 31, 1900—Continued.

DEPARTURES.

Trade engaged in.	Steamers.		Sailing vessels.		Barges.	
	Number.	Registered tonnage.	Number.	Registered tonnage.	Number.	Registered tonnage.
Home, on lake	213	49,408	85	11,850	51	16,594
Foreign, on lake	340	56,712	398	75,755	216	71,152
Total	553	106,120	483	87,605	267	87,746

Total departures, 1,303; registered tonnage, 281,471.
Greatest draft of vessel, 14.3 feet.
Greatest tonnage of vessel, registered tonnage, 1,552.
Greatest load of vessel, net tons, 1,304.

S S 7.

IMPROVEMENT OF HARROR AT CAPE VINCENT, NEW YORK.

ORIGINAL CONDITION.

In its original condition Cape Vincent was an open roadstead on the St. Lawrence River, 2½ miles from Lake Ontario.

PROJECT FOR IMPROVEMENT.

The original project, adopted in 1896, was to build a breakwater parallel to and 600 feet from the railroad wharf 1,600 feet in length, at an estimated cost of $320,000. This project was modified in 1899 to build a breakwater parallel to and 500 feet from the railroad wharf 1,500 feet long, including a shore return at the upper end 100 feet long, at an estimated cost of not over $200,000.

A map of this harbor faces page 3288 of the annual report for 1897; the estimated cost of each 100 linear feet of breakwater is given on page 3146 of the report for 1899, and the details of construction of the breakwater are shown on the drawings facing that page. Those drawings show the length of the river-arm cribs as 100 feet, but the four cribs built in 1900 are 90 feet long each instead of 100 feet.

It was proposed with the $50,000 then available, appropriated by the acts of June 3, 1896, and March 3, 1899, to build three river-arm cribs each 100 feet long and a shore-return 50 feet long, in all 350 feet, and specifications were issued accordingly. When the proposals were opened, however, it was found that the lowest bid received would permit the building of 60 feet additional, or 410 feet in all, and contract was therefore entered into for constructing four river-arm cribs each 90 feet long and a shore-return 50 feet long.

The total amount expended on this improvement to June 30, 1900, was $854.39, and the amount expended during the year ending June 30, 1901, was $47,316.26.

REPORT OF OPERATIONS.

Under the contract with James B. Donnelly, of Buffalo, N. Y., the work of filling the foundation trench with stone was completed, and four river-arm cribs, each 90 feet long, and a shore-return 50 feet long, were built. Work under the contract commenced June 2 and was completed November 20, 1900.

A light was maintained on the completed part of the breakwater from November 20, 1900, until the close of navigation, January 20, 1901, and from April 11, 1901, until the close of the fiscal year.

REMARKS.

This breakwater is designed, not to protect an anchorage, but for vessels to moor to and to protect vessels moored at the wharves at Cape Vincent, and the following extracts from letters of masters of vessels plying between Lake Ontario and the St. Lawrence River and from vessel owners testify to the value of that part of the breakwater now completed:

[From the Ogdensburg Coal and Towing Company.]

* * * The masters of our vessels plying between Lake Ontario and the St. Lawrence River last season found the part of the breakwater at Cape Vincent built last year of the very greatest kind of service, and so valuable that we can not say to what an extent it benefits our company in safety to our boats by preventing them from dragging anchors and going ashore.

It is also the opinion of the masters, as well as our own, that it is not long enough, but should be increased considerably, which we trust will be done.

[From Capt. Joseph Saunders, Cape Vincent, N. Y.]

It was well used, and at times boats were tied up two or more deep during storms.

[From Capt. F. E. Wood, master steamer *Ringleader*.]

As to Cape Vincent breakwater, I did not have a chance to use it, but was in a place where I could see the service that it would be to others. The breakwater is just what is wanted, but not long enough as it is, in my opinion. * * * The breakwater was not finished in time to help much. I was in Cape Vincent and there was a bad blow, and I had to have a tug pull me from the dock. If I could have used the breakwater I would not have had that trouble and expense.

[From Capt. A. R. Hinckley, Cape Vincent, N. Y.]

* * * The breakwater that was built here last season proved to be just what we needed.

I had a good chance to try it during the gales last fall.

What we want is an extension of the main part. It would not shelter one-fourth the boats looking for shelter during a gale.

[From Capt. W. A. Russell, master steam tug *Wm. L. Proctor*.]

* * * If the breakwater had been finished earlier in the season it would have been used a great deal. I had to use the railroad wharf several times. On one occasion there were ten vessels there waiting weather.

[From Capt. D. Hourigan, master steamer *Hecla*.]

* * * In regard to the breakwater at Cape Vincent, it is the right thing and in the right place for boats going up and down the river.

Late in November last fall I was bound for Charlotte. The wind was blowing a gale from northeast. It set in snowing very hard. We stopped on the north side of the breakwater and lay there two days comfortably. Inside the breakwater lay two tugs and a small steam barge during that blow. Boats had to be towed away from the docks at Cape Vincent; the waves beat over them so that it was not safe to lie there.

I think the return at the upper end is plenty long, for it is sheltered by the point of land above the breakwater; but if the breakwater extended down the river about 2,000 feet more it would be a great protection to navigation.

From the foregoing letters and from observation while work was in progress last season, the value of this breakwater to the shipping plying between Lake Ontario and the St. Lawrence River is established beyond a doubt. The 410 feet built in 1900, while of much usefulness, as shown by the above letters, is inadequate, and the speedy appropriation of funds to complete the construction of the breakwater to the full length authorized by the project is much to be desired.

The estimate for building this breakwater is $200,000. Of this amount $50,000 has been appropriated, with which about one-fourth of the work contemplated has been finished. It is therefore recommended that the entire balance, $150,000, be appropriated in the next river and harbor bill.

Money statement.

July 1, 1900, balance unexpended	$49,145.61
June 30, 1901, amount expended during fiscal year	47,316.26
July 1, 1901, balance unexpended	1,829.35
Amount (estimated) required for completion of existing project	150,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	150,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

Appropriations.

Date.	Amount.	Aggregate.
June 3, 1896	$25,000	$25,000
March 3, 1899	25,000	50,000

COMMERCIAL STATISTICS.

Class of goods.	Net tons.	Class of goods.	Net tons.
Stone	3,453	Posts and wood	67
Poles and railroad ties	2,655	Iron and iron ore	55
Lumber	2,649	General merchandise	434
Shingles	527		
Hay	499	Total	10,721
Fish	382		

Increase over last year, 7,788 tons.
Number of passengers carried, 18,317.
Increase in number of passengers carried, 293.

Statement of vessels at Cape Vincent, N. Y., for the calendar year ending December 31, 1900.

ARRIVALS.

Trade engaged in.	Steamers.		Sailing vessels.		Barges.	
	Number.	Registered tonnage.	Number.	Registered tonnage.	Number.	Registered tonnage.
Home	86	2,296	10	335	10	3,045
Foreign	339	65,655	45	1,634	14	5,054
Total	425	67,951	55	1,969	24	8,099
American owned	254	27,120	18	621	13	3,145
Canadian owned	171	40,831	37	1,348	11	4,954

Total arrivals, 504; registered tonnage, 78,019.

DEPARTURES.

Trade engaged in.	Steamers.		Sailing vessels.		Barges.	
	Number.	Registered tonnage.	Number.	Registered tonnage.	Number.	Registered tonnage.
Home	42	3,204	10	335	21	7,358
Foreign	383	64,747	45	1,634	3	741
Total	425	67,951	55	1,969	24	8,099

Total departures, 504; registered tonnage, 78,019.
Greatest draft of vessel, 14 feet.
Greatest tonnage of vessel, registered tonnage, 585.
Greatest load of vessel, net tons, 473.

S S 3.

IMPROVEMENT OF SHOALS IN THE ST. LAWRENCE RIVER BETWEEN OGDENSBURG, NEW YORK, AND THE FOOT OF LAKE ONTARIO.

ORIGINAL CONDITION.

In its original condition the channel of the St. Lawrence River from Sister Islands light down to the head of Brockville Narrows was obstructed by twelve ledges on which the depth was 9½ to 16 feet at low water.

PROJECT FOR IMPROVEMENT.

The original project of 1890 was to remove ledges between Sister Islands and Crossover lights to 18 feet below the zero of the Ogdensburg gauge, at an estimated cost of $43,305. In 1893 several outlying spurs were discovered and their removal included in the project, and the estimated cost increased to $54,772. By act of June 3, 1896, the project was extended to embrace ledges in the St. Lawrence River between Ogdensburg and the foot of Lake Ontario. In 1897 the removal of the obstructions to 18 feet below the zero of the Oswego gauge (1.4 feet greater) was included in the project, increasing the total estimated cost to $108,000.

The total amount expended on this improvement to June 30, 1900, was $60,977.60, all of which was for works of improvement. The amount expended during the fiscal year ending June 30, 1901, was $5,911.66.

REPORT OF OPERATIONS.

Work under the contract with William J. Daly, of Ogdensburg, N.Y., which commenced in July, 1899, was completed September 30, 1900.

The work done during the fiscal year commencing July 1, 1900, consisted of drilling and blasting shoals E and L, and dredging shoals E, H, J, and L all to 18 feet below the zero of the Oswego gauge.

REMARKS.

All the shoals in American waters embraced in the project have now been removed to the prescribed depth.

Shoals A, B, and C, also embraced in the project, are in Canadian waters. Application for permission to remove these shoals was made through the Department of State to the Canadian government, and on December 22, 1899, the necessary permission was granted. These shoals will be removed as soon as funds become available.

It is estimated that there will be required to June 30, 1903, for completing the project $40,000, and the appropriation of this amount is recommended.

Money statement.

July 1, 1900, balance unexpended	$7,022.40
June 30, 1901, amount expended during fiscal year	5,911.66
July 1, 1901, balance unexpended	1,110.74
Amount (estimated) required for completion of existing project	40,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	40,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

Appropriations.

Date.	Amount.	Aggregate.
Act of—		
September 19, 1890	$5,000	$5,000
July 13, 1892	10,000	15,000
August 18, 1894	8,000	23,000
June 3, 1896	25,000	48,000
March 3, 1899	20,000	68,000

S S 9.

IMPROVEMENT OF HARBOR AT OGDENSBURG, NEW YORK.

ORIGINAL CONDITION.

In its original condition the low-water depth in this harbor was 9 feet in the channel leading to the Oswegatchie River, 10 to 12 feet in the two lower entrance channels, and 6 to 12 feet along the city front.

PROJECT FOR IMPROVEMENT.

The original project of 1868 was to dredge to the depth of 12 feet and to build, if necessary, 5,500 linear feet of piers, at an estimated cost of $100,000. The piers were never built. The project of 1882 provided for dredging the channel across the shoal to the mouth of the Oswegatchie to 16 feet and all other channels to 15 feet at extreme low water, at an estimated cost of $76,000. The present project provided for dredging all the channels to a depth of 16½ feet below the zero of the Ogdensburg gauge (15 feet below the zero of the Oswego gauge), at an estimated cost of $158,950. The project was modified February 27, 1897, to deepen the two lower entrance channels to 16 feet below the zero of the Oswego gauge, and, by act of March 3, 1899, was further modified to dredge 900 feet of the channel along the front of Ogdensburg, above Franklin street, to but 14 feet below the same zero, elsewhere the project depths to remain 15 feet.

The total amount expended on this improvement to June 30, 1900, was $290,548.45, of which $257,247.30 was for construction and $33,301.15 for maintenance. The total amount expended during the fiscal year ending June 30, 1901, was $6,170.58.

REPORT OF OPERATIONS.

Under supplemental contract with William J. Daly, of Ogdensburg, N. Y., the channel along the city front was redredged in October and November, 1900, to 15 feet below the zero of the Oswego gauge by the removal of 20,000 cubic yards of sand, etc.

REMARKS AND ESTIMATE.

In order to obtain the depth of 15 feet below the zero of the Oswego gauge in that part of the harbor situated in the mouth of the Oswegatchie River, it will be necessary to dredge about 14,000 cubic yards, scow measurement, of hardpan and bowlders. It was proposed to remove this tongue of hardpan under the last two appropriations, but owing to insufficiency of funds it was not done.

It is estimated that there will be required to June 30, 1903:

For removing hardpan at mouth of Oswegatchie River	$7,000
For redredging, engineering, and office expenses	13,000
	20,000

The total commerce at this port during the calendar year endnig December 31, 1900, was 646,248 tons, of which 199,158 tons were grain received from the Upper Lakes, 192,923 tons coal received from ports on Lake Ontario, 148,731 tons lumber, and 105,436 tons miscellaneous freight.

Money statement.

July 1, 1900, balance unexpended		$6,807.11
June 30, 1901, amount expended during fiscal year		6,170.58
July 1, 1901, balance unexended		636.53
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901:		
For works of improvement	$7,000	
For maintenance of improvement	13,000	
		20,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

Appropriations and allotments.

Date.	Amount.	Aggregate.
August 30, 1852	$3,000.00	$3,000.00
March 2, 1867	40,000.00	43,000.00
July 17, 1870	15,000.00	58,000.00
March 3, 1871	25,000.00	83,000.00
June 10, 1872	10,000.00	93,000.00
March 3, 1873	6,000.00	99,000.00
June 23, 1874	6,000.00	105,000.00
March 3, 1875	5,000.00	110,000.00
December 11, 1877 (from appropriation for "Repairs of harbors on northern lakes")	5.56	110,005.56
September 10, 1879 (from appropriation for "Examinations, surveys, and contingencies of rivers and harbors")	300.00	110,305.56
July 28, 1880 (from appropriation for "Examinations, surveys, and contingencies of rivers and harbors")	50.00	110,355.56
August 2, 1882	10,000.00	120,355.56
July 5, 1884	15,000.00	135,355.56
August 5, 1886	10,000.00	145,355.56
August 11, 1888	15,000.00	160,355.56
September 19, 1890	42,000.00	202,355.56
July 13, 1892	40,000.00	242,355.56
August 18, 1894	20,000.00	262,355.56
June 3, 1896	20,000.00	282,355.56
March 3, 1899	15,000.00	297,355.56

COMMERCIAL STATISTICS.

	Net tons.		Net tons.
Grain	199,158	Culm	58
Coal	192,923	Ore	17
Lumber	148,731	Posts and wood	18¼
Poles and railroad ties	5,539	Oil	3
Hay	1,934	General merchandise	96,150½
Iron and steel	925		
Shingles	646¼	Total	646,248
Wire	150		

Decrease since last year, 24,135 tons.
Number of passengers carried, 187,553.
Increase in number of passengers carried over last year, 19,089.

Total duties collected	$188,595.86
Total fees collected	35.10
Value of imports	10,317,379.00
Value of exports	4,827,857.00
Value of merchandise warehoused	128,187.00
Value of merchandise warehoused and transshipped in bond	85,960.00
Amount of duties on above	13,309.53
Value of merchandise entered for transshipment and export	266,902.00
Amount of duties on above, estimated	47,147.68
Quantity and value of lumber imported	713,737.00
Value of merchandise entered for immediate transportation, packages, 19,142	274,247.00
Estimated duties on above	95,686.77
Value of merchandise imported in cars	10,083,998.00
Value of merchandise exported in cars	3,833,196.00

Merchandise received under consular seal from foreign ports, 1900.

Class of goods.	Packages, number.	Value.	Class of goods.	Packages, number.	Value.
Matting	190	$732.78	Straw braid	4,908	$174,896.00
Silk goods	705	398,683.00	Curios	4,528	91,879.24
Tea	20,875	221,714.00	Miscellaneous	35,996	966,528.61
Chinese groceries	3,127	49,063.00			

Statement of vessels at Ogdensburg Harbor, New York, for the calendar year ending December 31, 1900.

ARRIVALS.

Trade engaged in.	Steamers.		Sailing vessels.		Barges.	
	Number.	Registered tonnage.	Number.	Registered tonnage.	Number.	Registered tonnage.
Home	674	252,902	54	17,344	64	18,519
Foreign	1,484	131,316	45	7,449	262	86,422
Total	2,158	384,218	99	24,793	326	104,941
American owned	1,607	359,414	62	19,955	138	40,666
Canadian owned	551	24,804	37	4,838	188	64,275

Total arrivals, 2,583; registered tonnage, 513,952.

DEPARTURES.

Trade engaged in.	Steamers. Number.	Steamers. Registered tonnage.	Sailing vessels. Number.	Sailing vessels. Registered tonnage.	Barges. Number.	Barges. Registered tonnage.
Home	806	272,523	72	22,840	219	75,691
Foreign	1,354	114,323	33	4,173	106	28,929
Total	2,160	386,846	105	27,013	325	104,670

Total departures, 2,590; registered tonnage, 518,529.

Greatest draft of vessel	feet..	16
Greatest tonnage of vessel	registered tonnage..	1,553
Greatest load of vessel	net tons..	2,528

S S 10.

EXAMINATION AND SURVEY OF GRASSE RIVER, NEW YORK.

[Printed in House Doc. No. 151, Fifty-sixth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, December 6, 1900.

SIR: I have the honor to submit herewith copies of reports dated August 2 and November 29, 1900, with map,[1] by Capt. Graham D. Fitch, Corps of Engineers, upon preliminary examination and survey of Grasse River, New York, from its confluence with the St. Lawrence River to Massena, with a view to obtaining a depth of 21 feet, made to comply with requirements of the emergency river and harbor act of June 6, 1900.

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[1] Not reprinted; printed in House Doc. No. 151, Fifty-sixth Congress, second session.

In his report on preliminary examination of the locality the local officer stated that in his opinion Grasse River was not worthy of improvement to a depth of 21 feet, but that a survey of the river with a view to determining the cost of work necessary to obtain a depth of 15 feet from its confluence with the St. Lawrence River to its junction with the St. Lawrence Power Company's canal was worthy of being made, and his views were concurred in by the division engineer, Col. G. L. Gillespie, Corps of Engineers.

In the accompanying report on survey a plan is presented for excavating a channel 12 feet deep from a point about 1,400 feet below the St. Lawrence Power Company's power house at Massena to the confluence of the Grasse River with the St. Lawrence, at an estimated cost of $200,000.

Captain Fitch reports that there is no present commerce demanding the improvement of Grasse River, but that the St. Lawrence Power Company is constructing, at a cost of $4,500,000, a very large power plant at Massena, on the Grasse River. It is anticipated that extensive manufacturing interests will be established at Massena as a result of the power available, and such establishments when put in operation would be materially benefited by an improvement of Grasse River to the extent of furnishing a navigable depth of 12 feet.

Very respectfully, your obedient servant,

John M. Wilson,
Brig. Gen., Chief of Engineers,
U. S. Army.

Hon. Elihu Root,
Secretary of War.

PRELIMINARY EXAMINATION OF GRASSE RIVER, NEW YORK, FROM ITS CONFLUENCE WITH THE ST. LAWRENCE RIVER TO MASSENA, WITH A VIEW TO OBTAINING A DEPTH OF 21 FEET.

United States Engineer Office,
Oswego, N. Y., August 2, 1900.

General: In compliance with the requirements of letter from your office of June 13, 1900, I have the honor to submit the following report on the preliminary examination called for by the paragraph of the act of Congress approved June 6, 1900, reading, "Grasse River, from its confluence with the Saint Lawrence River to Massena, with a view to obtaining a depth of twenty-one feet."

The Grasse River was surveyed in 1880 and a project submitted in 1881 (Annual Report of the Chief of Engineers for 1881, p. 2457), by Major McFarland, for improving it from its mouth to Haskell's Wharf, by dredging a channel 4 feet deep at low water and 40 feet wide, at an estimated cost of $12,000. The first work was done in 1888, when, at a cost of $1.76 per cubic yard, 1,670 cubic yards at the rapids were removed by dredging after the hard material had been removed by dynamite. In 1890 and 1891 the project was completed by the removal of 1,119 cubic yards from the Rapids Shoals, 1,475 cubic yards from Haskell's Wharf Shoals, and 2,571 cubic yards from other localities.

The examination of Grasse River was made by me in a small naphtha launch on July 19, after I had spent the previous day in going over the work now in progress by the St. Lawrence Power Company. During the evenings of July 18 and 19 representative citizens of Massena, officials of the St. Lawrence Power Company and of the T. A. Gillespie Company, its contractors, were interviewed by me on the subject of the desired improvement.

The Grasse River rises in the Adirondacks, in the southeastern part of St. Lawrence County, N. Y., and lies in that county throughout its course. Its three branches unite near the center of the county, whence it flows in a northerly direction for about 30 miles and then in a northeasterly direction for about 20 miles until it empties into the St. Lawrence River opposite Cornwall, Canada. The channel in the St. Lawrence River at this point is 25 to 40 feet deep, and has a current of about 4 miles per hour. From where the power canal joins it, about one-half mile below Massena village, to its mouth, Grasse River flows in a generally straight course with but two sharp curves through about 7 miles of undulating meadow land, the river valley itself being bordered by low hills 30 to 40 feet in height, whose crests are at an average distance of 300 yards apart.

The slopes are gradual in most cases and a heavy growth of grass reaches down to the water's edge. The banks, which are a sandy loam, show no signs of washing or caving, and there are no indications of silt being deposited in the river. At frequent intervals, especially in the lower half of the 7 miles, there are considerable stretches of level bottom land but slightly above the water surface. These flats would make excellent dumping grounds for dredged material. The river averages about 350 feet in width, beginning to broaden, however, a mile above its mouth, which is about 1,200 feet wide. The depths in the channel seem to vary between 4 and 10 feet. The bed of the river appears to be mainly mud, sand, and clay, though bowlders were seen in the river about 3 miles below Massena, as well as along the banks in a few places. The experience of the Government in 1890 and 1891, and of the St. Lawrence Power Company in its canal, renders it probable that hardpan is present. No outcroppings of rock were noticed below the power canal.

During the open season, from about May 1 to about November 1, the variation in water level does not exceed 2 feet, I am informed; but in winter extraordinary backwater rises from the St. Lawrence sometimes occur, the maximum range recorded by the local engineer of the St. Lawrence Power Company being 24.5 feet. The slope of the Grasse River below Massena is very slight, the discharge is small, and the current hardly perceptible. There are no bridges across the river from Massena to its mouth.

Massena is a thriving village of about 3,000 inhabitants. It is an agricultural center, dairying being the main industry, and it ships considerable quantities of butter, most of which goes to Boston. Branches of two railroads, the Grand Trunk Railroad of Canada and the New York Central and Hudson River Railroad, pass through it. One small passenger boat, the *Gracie*, drawing 3 feet of water, navigates the Grasse River, making daily trips to Cornwall, Canada.

The present demands of commerce are sufficiently provided for, and the improvement desired is wholly for such prospective demands of commerce as may result from the work now being done by the St. Lawrence Power Company. This company is constructing, at a cost of about $4,500,000, a very large power plant on the Grasse River.

The water furnishing the power is to be taken from the St. Lawrence River by a canal now under construction. This canal leaves the St. Lawrence River near the head of Long Sault Island, and is 16,200 feet long. It will be 196.50 feet wide at the water line, 18 feet deep, and have slopes of 1 on 1½. About 5,600,000 cubic yards of material must be excavated for this canal, as it passes through two ridges each over 2,000 feet long, requiring cuts of 80 and 90 feet, respectively. The average excavation per month is 225,000 cubic yards, by 6 steam shovels and 4 dredges, namely, 1 dipper dredge delivering to scows, which are dumped in deep water in the St. Lawrence River; 2 suction dredges with cutters operated by centrifugal pumps and discharging through pipes, and an "orange-peel" dredge, emptying into an attached steel chute, whence the material, after being disintegrated by jets of water, is discharged, by means of a vacuum pump, through pipes.

The canal, when finished, is to have a discharge of 14,000 cubic feet per second, with a current less than 3½ miles per hour. The water in the canal at its lower terminus will be 40 feet above the ordinary water level of the Grasse River, which will form the tailrace of the plant. The bottom of the Grasse River at this point is rock, giving a good foundation for the power house, which will be of concrete and be 304 feet long, 72 feet wide, and 85 feet high. The power plant now under construction will develop 35,000 electrical horsepower, but there is provision for the future development of 40,000 additional horsepower. There will be at first 7 generating units, each unit consisting of 3 pairs of inward-flow turbines and a 5,000-horsepower generator on a single horizontal shaft.

Begun in 1897 and continued since 1898 by the present company, this undertaking is now about two-thirds completed, and the plant is expected to be ready to supply power by May 1, 1901. Inquiries for 80,000 horsepower have already been received, and as the St. Lawrence Power Company own about 2,000 acres of ground suitable for manufacturing purposes, and will be able to sell power at very low rates (from $12 to $15 per horsepower per annum, I am informed), there is no doubt that extensive manufacturing industries will be established at Massena, and that these industries will create a considerable commerce of a general rather than of a local character, and though the Massena Canal, upon its completion, will afford, via the Cornwall Canal, direct water communication with Montreal, there is, nevertheless, little doubt that the future commerce of Massena will be much benefited by improving the Grasse River sufficiently to permit its navigation by St. Lawrence River vessels, thus affording a shorter route to Montreal, and avoiding about 11 miles of Canadian canals with five locks, besides 4 miles of river. As, however, the depth on the miter sills of the canals between Massena and Montreal is 14 feet, there is in any event, according to my judgment, no apparent reason for securing more than 15 feet depth in the Grasse River. Whether or not this depth can be obtained at an expense which the commercial advantages resulting therefrom would justify can only be determined after an accurate survey. The cost of such a survey, including the necessary borings, would be $1,000.

In my opinion the Grasse River is not worthy of being improved to a depth of 21 feet, but from its confluence with the St. Lawrence River to its junction with the St. Lawrence Power Company's Canal it is worthy of a survey for the purpose of determining the cost of the work necessary to obtain a depth of 15 feet.

I have the honor to forward herewith five[1] photographs taken by myself of the Grasse River and of the uncompleted Massena Canal; also copies of five letters received by me in response to inquiries.

Very respectfully, your obedient servant,

GRAHAM D. FITCH,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

NORTHEAST DIVISION, ENGINEER OFFICE,
New York, August 6, 1900.

Respectfully forwarded to the Chief of Engineers, concurring in the views of the district officer.

G. L. GILLESPIE,
Colonel, Corps of Engineeers,
Division Engineer.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
August 9, 1900.

Respectfully submitted to the Secretary of War.

This is a report upon preliminary examination of Grasse River, New York (full text of item quoted within), made to comply with requirements of the emergency river and harbor act of June 6, 1900.

For reasons given within this river is not considered by the local officer worthy of being improved to a depth of 21 feet, but that portion of the river from its confluence with the St. Lawrence River to its junction with the St. Lawrence Power Company's Canal is considered worthy of a survey for the purpose of determining the cost of the work necessary to obtain a depth of 15 feet.

I recommend that a survey be made in accordance with the views expressed within by Captain Fitch and concurred in by the division engineer.

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

[Third Indorsement.]

WAR DEPARTMENT,
August 14. 1900.

Approved as recommended by the Chief of Engineers.

ELIHU ROOT,
Secretary of War,

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[1] Not printed.

LETTER OF THE T. A. GILLESPIE COMPANY.

THE T. A. GILLESPIE COMPANY,
Massena, N. Y., June 25, 1900.

DEAR SIR: I am in receipt of your letter of June 19, asking for information concerning the commercial importance of the St. Lawrence and Grasse rivers. In reply to your inquiry—

(1) Would say that the present commerce of the Grasse River between Massena and the confluence of the Grasse and St. Lawrence rivers is very small. This is largely due to the fact that there is not sufficient depth of navigable water. As you are aware, we are now constructing the Massena Canal for the development of a large power, at an expenditure of nearly $5,000,000, with a view to establishing extensive manufactories along this canal. When the canal is completed and the water out of the St. Lawrence River passes through it it will increase the depth of the Grasse River about 6 or 8 feet.

As you are aware, Cornwall is quite a manufacturing point, on the Canadian side, opposite Massena, and with sufficient water between these points there should be considerable business done, as Massena, with this new power development, will be the first important town on the American side of the river.

(2) In answer to your second inquiry, would say that the St. Lawrence Power Company has in view—as I have already stated in my answer to your first query—the establishment of large manufacturing concerns for the utilization of this power, and the construction of a lock at the Grasse River end of the canal would enable vessels to pass through on their way around the Long Sault Rapids.

It is well known that the lumber used for the manufacture of wood pulp is rapidly diminishing on the American side and that the great source of supply for this product in the future will be on the Canadian side, in the vicinity of Ottawa. It will therefore be the aim of the St. Lawrence Power Company to induce the paper industries to locate at this point, and it is absolutely necessary that sufficient water be in the Grasse River to permit of the vessels passing up with the raw material and taking away the finished product, or to permit vessels coming from the west with any cargo to enter the canal. The Massena Canal will have a depth of about 18 feet of water, and a lock built at the Grasse River end of the canal will allow vessels to pass around the Sault Rapids. From the best information I can obtain from the towing companies engaged on the St. Lawrence River, they would thereby be enabled to go through the Massena Canal and around the Sault Rapids in about an hour and a half to two hours, instead of taking, as they do now, from five to six hours through the Cornwall canals.

(3) Answering your third query, would say that a depth of 18 or even 16 feet would be sufficient over the shoals of the St. Lawrence River, as above and below Massena the canals are not anywhere over 16 feet that we know of. Therefore it would not be necessary to make the depth greater than 16 feet at this point.

(4) In answer to your fourth inquiry, would say that I am informed that there is a very great tonnage of coal, lumber, wheat, etc., passing annually through the Cornwall Canal, in American bottoms, that by passing through the Massena Canal could be diverted into American waters. Aside from this, we believe that this will be a very large transfer point, as at present, for instance, at Ogdensburg, especially as there will be three competing railroads in the vicinity of the Massena Canal. The St. Lawrence Power Company has now a railroad built connecting the Grand Trunk and the New York Central with the canal, and will in a very short time be connected with the New York and Ottawa Railroad. With the deepening of the channel and the shoals of the St. Lawrence River vessels can pass through the Massena Canal and transfer their cargoes to the different railroads at this point.

One of the principal industries that we expect to develop largely by the furnishing of cheap power is the manufacture of flour, and also the reduction of copper, the raw materials coming from the Northwest by vessels through the Lakes.

It must be borne in mind that this is the first canal on the American side that is being developed by private capital; that its depth is sufficient for shipping, and that the bridges now being constructed across it will allow any vessel navigating the St. Lawrence River to pass beneath them.

Yours, very truly,

T. A. GILLESPIE,
President.

GRAHAM D. FITCH Esq.,
Captain, Corps of U. S. Engineers.

LETTER OF THE ST. LAWRENCE POWER COMPANY OF MASSENA, N. Y.

St. Lawrence Power Company of Massena, N. Y.,
New York, June 29, 1900.

Dear Sir: Yours of June 19 was forwarded to the writer by Mr. Kellogg, and came to hand during his absence from town, which accounts for delay in reply.

1. The commerce of the Grasse River from its confluence with the St. Lawrence to Massena is very small at the present time, and is represented practically by one small boat which runs from Cornwall to Massena. The exact value or amount of this traffic I am unable to give you at this writing, but it certainly is small. One reason for this small commerce at the present time is the fact that there is but 3 or 4 feet of water at certain points in the channel of the Grasse River.

2. When that part of the Grasse River is improved to a depth of 21 feet, or thereabouts, it is fair to assume, in the first place, that shipments to and from Montreal and Quebec from the northern district of New York State will be made through this channel during the open months of the year, and thus this part of the country will be greatly benefited in the matter of foreign shipments. In the second place, when the canal of the St. Lawrence Power Company is completed between the St. Lawrence River and the Grasse River the commerce of the St. Lawrence River will pass through this channel in preference to the Cornwall Canal, as it will be a shorter route and there will be fewer locks. This commerce, as you know, amounts to an enormous tonnage every year.

Massena being a railroad center, with competition by the Grand Trunk and New York Central, and further competition in the near future by the New York and Ottawa, with proper water facilities down the river, should become quite a large port of entry.

3. As to the depth of water in the river, for the present doubtless 18 feet would be ample, but if, as we understand is contemplated, the Lachine Canal is increased to a depth of 20 feet, then seagoing vessels drawing that depth of water could land at Massena or proceed through the Massena Canal up the river.

4. As to what commerce might be anticipated to pass over this part of the St. Lawrence River, if the rocks were removed so as to give a navigable depth of 20 feet, I should say that all the commerce now going up and down the St. Lawrence River would pass this way in preference to going by the Cornwall Canal. If this depth of water can be maintained from the St. Lawrence River above the mouth of the Massena Canal to the confluence of the Grasse River with the St. Lawrence River, it would form one of if not the most important link between Lake Ontario and the easternmost point in the United States on the St. Lawrence River.

5. The future prospects of Massena, owing to the development there of a large water power, are very great, and as many of the electro-chemical products which will be manufactured at Massena find a large market abroad, water communication from this point to a shipping port is a matter of great importance to this community. It will be the forming of a ship water way on the American side of the St. Lawrence, and is certainly a matter of great importance to the entire lake region, as shipments then can be made from the lake regions directly to the ocean. It is hoped that with a depth of 20 feet of water in the Grasse River shipments in bulk can be made from Massena to foreign ports.

Yours, very truly,
Wm. F. Zimmerman,
Vice-President and General Manager.

Graham D. Fitch, Esq.,
Captain, Corps of Engineers, U. S. A.

LETTER OF MR. HENRY H. WARREN.

Clerk's Office, Massena Village Corporation,
Massena, N. Y., July 26, 1900.

Sir: In connection with the proposed enlargement of the Grasse River, I beg to submit the following facts for your consideration:

The preliminary steps have been taken toward the establishment of a large flour-milling plant here, and a pulp and paper plant is in view and I believe will be built in time to utilize a part of the power now being developed, and it is earnestly hoped that the deepening of the Grasse River will be proceeded with, as it will give direct connection by water with New York City and Montreal and enable these and other industries to do a large export trade and effect a saving of about 50 cents per ton—amounting to $50,000 per annum—on these two lines alone during the season of navigation.

One hundred tons flour per day, at $1.40 by rail or 80 cents by water, makes a saving of $60; 500 tons of pulp, at $1.20 by rail or 80 cents by water, makes a saving of $200. For two hundred days of navigation this would amount to $52,000. Many and varied industries will be located here, drawn by the power now nearing completion, and it is only fair to assume that a proportionate saving can be made on their output for export.

Respectfully, yours,

HENRY H. WARREN,
President.

GRAHAM D. FITCH,
Captain, Corps of Engineers, U. S. A.

LETTER OF THE OGDENSBURG COAL AND TOWING COMPANY.

OGDENSBURG COAL AND TOWING COMPANY,
Ogdensburg, N. Y., August 1, 1900.

DEAR SIR: Yours of July 30 received. I can not give you just what the freight rates are on grain and coal from Ogdensburg to Montreal. There is no doubt in my mind but a great saving would be effected in freight rates if the Grasse River were improved to 15 feet, so that shipments could be made from the Massena district down the St. Lawrence River via the Grasse River instead of via the new Massena Canal to the Cornwall Canal and thence down the St. Lawrence River.

Can not give an estimate of what the saving would be.

Yours, truly,

JOHN HANNAN.

GRAHAM D. FITCH,
Captain, Corps of Engineers, U. S. A.

LETTER OF MR. HENRY H. WARREN.

CLERK'S OFFICE, MASSENA VILLAGE CORPORATION,
Massena, N. Y., August 1, 1900.

SIR: Replying to your favor of the 27th ultimo, would state that I am informed by river boatmen that freight rates from Massena down the St. Lawrence River to Montreal or New York via Massena Canal and Cornwall Canal would be nearly double the rates between same points via Grasse River into St. Lawrence River, for the following reasons:

First. The increased distance.

Second. The extra cost of towing against the excessive currents from the head of the Massena Canal to the Cornwall Canal.

Third. The extra time consumed by five lockages each way in the Cornwall Canal.

From personal experience I know these reasons to be valid.

Respectfully,

HENRY H. WARREN,
President.

Mr. GRAHAM D. FITCH,
Captain, Corps of Engineers, U. S. A.

SURVEY OF GRASSE RIVER, NEW YORK, FROM ITS CONFLUENCE WITH THE ST. LAWRENCE RIVER TO ITS JUNCTION WITH THE ST. LAWRENCE POWER COMPANY'S CANAL, WITH A VIEW TO OBTAINING A DEPTH OF 15 FEET.

UNITED STATES ENGINEER OFFICE,
Oswego, N. Y., November 29, 1900.

GENERAL: In compliance with the requirements of letter from your office of August 25, 1900, I have the honor to submit the following report on a survey of Grasse River, New York, from its confluence with the St. Lawrence River to its junction with the St. Lawrence Power Company's canal, with an estimate of the cost of the work necessary to obtain a depth of 15 feet, and a statement of the amount of improvement that in my judgment the commerce involved will justify. The survey was made under the direct supervision of Assistant Engineer John C. Churchill, jr., whose report is transmitted herewith.

The river bottom to a depth of 15 feet below low water was found to consist of sand and soft clay, with occasional deposits of hardpan, and a small amount of rock. As rock is found near the water surface at the power house but disappears below grade about 1,400 feet below, it is assumed that any improved channel will end at the latter point. An outline of the proposed channel is shown upon the accompanying map.

The amounts of material to be removed and the cost of the work necessary to obtain a channel in the Grasse River 15 feet deep at extreme low water and 100 feet wide from its confluence with the St. Lawrence River to a point 1,400 feet below the St. Lawrence Power Company's power house are estimated as follows:

1,338,000 cubic yards of sand, mud, and clay, at 15 cents	$200, 700
190,000 cubic yards of hardpan, at 25 cents	47, 500
5,000 cubic yards of rock, at $3	15, 000
	263, 200
Add for contingencies	36, 800
Total	300, 000

The St. Lawrence Power Company have nearly completed, at a cost of about $4,500,000, an electrical power plant, and will be ready early in 1901 to deliver 35,000 horsepower. For further information concerning the St. Lawrence Power Company's plant I respectfully invite attention to my report of August 2, 1900, on the preliminary examination of Grasse River.

The efficiency of the machinery employed, electric generators in combination with turbines, is such as to enable electric power to be produced and transmitted at but a fraction of the cost of electric or other power produced by means of even the best modern steam plants, and the St. Lawrence Power Company will therefore be able to furnish power at such low rates that manufacturing industries utilizing all the power developed will undoubtedly establish themselves in the vicinity of Massena. These industries will create a considerable commerce of a general rather than a local character even though the Grasse River remain unimproved. While this commerce is as yet wholly prospective, it is not, in my opinion, problematic, but assured, and this future commerce would be much benefited by improving the Grasse River sufficiently to permit its navigation by St. Lawrence River vessels.

Though the Power Canal upon its completion will, via the Cornwall Canal, afford Massena direct water communication with Montreal if the St. Lawrence River at the head of Long Sault Island is improved, yet the Grasse River, if improved, would afford a better terminus and a shorter route, avoiding about 12 miles of Canadian canals, with 6 locks, besides 9 miles of river, as the strength of the current between Long Sault Island and Croils Island would compel boats to ascend the river above the latter island. Were the Grasse River route the only possible water route the expenditure of even $300,000 would be justified, as is shown by the annual saving in freight rates by water over that by rail on pulp wood from the same source of supply—Three Rivers, Quebec, to Massena—amounting to $28,000.

The cost of improving Grasse River can, however, be considerably reduced if a 12-foot channel in lieu of a 15-foot channel be adopted. The amounts of material to be removed and the cost of work necessary would then be as follows:

950,000 cubic yards sand, mud, and clay, at 15 cents	$142,500
137,000 cubic yards hardpan, at 25 cents	34,250
	176,750
Add for contingencies	23,250
Total	200,000

As the amount of river commerce to be benefited will depend somewhat upon the kind of factories locating at Massena and the points to which their products are shipped, as the commercial advantages of water communication via the Grasse River over the longer route via the Power Canal and the Cornwall Canal is not yet determinable, and as the 14-foot depth on Canadian miter sills is still so recent that the majority of present St. Lawrence River vessels can when fully loaded navigate a 12-foot channel, I do not consider the expenditure of $300,000, which would be necessary to secure a 15-foot channel, at present justifiable; but in my judgment the Grasse River is worthy of being improved by the General Government to the extent of securing a 12-foot channel from its confluence with the St. Lawrence River to about 1,400 feet below the St. Lawrence Power Company's power house, at an estimated cost of $200,000, provided appropriations are made so as to allow the continuous prosecution of the work.

Very respectfully, your obedient servant,

GRAHAM D. FITCH,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

REPORT OF MR. JOHN C. CHURCHILL, JR., ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Oswego, N. Y., November 26, 1900.

CAPTAIN: I have the honor to submit the following report, with maps, of my survey of Grasse River from its confluence with the St. Lawrence River to its junction with the St. Lawrence Power Company's canal at Massena, N. Y., a distance of about 7¼ miles, made under your direction September and October, 1900, to ascertain the cost of a channel 15 feet deep at extreme low water and of sufficient width for the passage of vessels which would probably use it.

In 1880 a survey, covering practically the part of Grasse River as outlined above, was made under the direction of Maj. Walter McFarland, and upon the survey was based a project for a channel of 4 feet depth.

Under that project an appropriation of $3,000 in 1883 and another of $6,000 in 1890 were made, with which several shoals were deepened and the improvement under the project completed.

The map of that part of Grasse River under consideration, submitted herewith, shows its general character.

The survey was made by running a transit line along the whole of the north side and part of the south side of the river, and the lines of soundings were located from the transit lines. Levels were run from the mouth of the river to the power house, and the contour lines were determined by the levels.

The river follows generally a northeast direction, and has but two decided bends in this part of it. It flows through a farming country between well-grassed banks, which slope gently in some places and abruptly in others back from the river. There are some low bottoms from 1 to 3 feet above extreme low water which are marshy and covered with a heavy growth of wild grass, and the river is bordered for nearly its whole length by thick masses of aquatic plants. The slopes are largely of glacial deposit underlaid with clay, which in many places shows near the water line. The clay is blue and stiff, and the slopes generally show little, if any, signs of wash, although during the spring floods there is a swift current and a rise of from 3 to 5 feet due to these floods.

At its low stage the river flows between the lines of marsh, which is composed of sand and soft clay, and which undoubtedly would be eroded by the action of a constant current of water.

Generally the bottom consists of sand and soft clay, but hardpan is encountered at the first bend above its mouth at Massena Center and at a point between these places. At the rapids near Massena Center the glacial deposit of hardpan and bowlders extends across the river, approaching the surface and, indeed, at low stage many bowlders are exposed. Through this shoal a channel was made 40 feet wide and 4 feet deep, under the appropriations for improving Grasse River.

Rock is found near the water surface at the power house, but disappears below grade about 1,400 feet below it, at which point the improved channel should stop. It is also found at a point 1¼ miles below the power house at depths of from 6 to 12 feet, but by pushing the channel into the north bank of the river the quantity of rock to be removed can be minimized by the excavation of a larger amount of much cheaper material, as the dip of the strata is to the north.

The ordinary summer flow of the river is small. The slope for the 7¼ miles under consideration is less than 0.5 foot at low stage, and the height of water for all the time, except during the spring floods, is determined by the elevation of water level in the St. Lawrence at its mouth. The current, therefore, is slight, and, except during the spring floods, which seldom last more than two weeks, carries very little suspended matter.

It is the intention of the St. Lawrence Power Company to use the Grasse River below the power house for the tailrace of its canal, and the effect of the water to be placed in the river must be considered in connection with any project for its improvement.

The present development of the Power Canal is for 35,000 horsepower. The power house is nearly completed. The placing of the turbines and electrical machinery to develop that amount of power is now in progress, and it is expected that by next spring all of this machinery will be in place. The estimated discharge of water to produce this power is 12,000 cubic feet per second. The effect of this discharge upon the Grasse River will be to raise the water level at the power house several feet, which will gradually diminish until it reaches the St. Lawrence, and produce a heavy current.

No dependence can be placed upon the increased height of water due to this discharge, for navigation purposes, because of the liability of its being shut off at any time at the power house. The passage of such a large body of water at high velocity will, without doubt, have a scouring effect upon the bottom of the river, which, it will be remembered, is largely sand and soft clay, but no deduction is made because of such probable scour from the quantities which the survey showed would have to be removed.

In making the estimate of cost I have estimated on a channel 15 feet deep at extreme low water and 100 feet wide, that width being, in my judgment, sufficient for the present improvement, but additional width is provided for at the bends of the river to give sufficient room for maneuvering the vessels using the channel. The excavation of this channel will greatly aid the passage of water from the power house to the St. Lawrence, and by increasing the cross section will reduce the head and therefore the velocity. Considering the present cross section of the river and the probable slope, it is safe to assume that with the additional area of the proposed channel the discharge of 12,000 cubic feet of water per second into Grasse River will not produce a current of more than 4 feet per second, and therefore such as to make the river unsafe for navigation.

The outline of the channel is shown upon the map of Grasse River. The method of improvement must necessarily be principally by dredging, although if the work of improvement is undertaken the current of the river can undoubtedly be used for carrying away large quantities of the soft materials to be removed.

The amounts of materials, measured in place, and the cost of removing them to deep water in the St. Lawrence, I estimate approximately as follows:

1,338,000 cubic yards sand, mud, and clay, at 15 cents	$200,700
190,000 cubic yards hardpan, at 25 cents	47,500
5,000 cubic yards rock, at $3	15,000
	263,200
Add for contingencies	36,800
Total	300,000

The Grasse River is now used by but one small steamboat, which plies between Cornwall, Canada, and Massena, N. Y. The commerce which would pass through this channel is entirely prospective, and will depend largely upon the business done upon the St. Lawrence Power Company's canal. As stated above, this company is developing 35,000 horsepower. It has put into this canal, the power house, and machinery about $4,500,000. The work upon the canal is in such shape that the company will be in readiness to deliver power early next year. The amount of money already expended and the character of the men who are back of this enterprise are guaranties that the power will be sold and used.

It is expected that a large amount of this power will be utilized in the manufacture of paper, and as the supply of pulp wood is obtained from Lower Canada, the cheapest means of transportation for this raw material is by water, if such transportation can be obtained. To give an idea of the saving in cost of this material, I would submit the following figures obtained, the rates being actual ones in existence:

The rate taken is to Cornwall, Canada, as that town is situated not far from Massena, on the St. Lawrence, and the rate to Massena would be approximately the same.

For the manufacture of a ton of paper there is required about 1⅜ tons of pulp wood, and a plant for the manufacture of 100 tons of paper per day will require 10,000 horsepower—less than one-third of the present development.

In one year there would be manufactured, say, 30,000 tons of paper, which would require 41,250 tons of pulp wood.

The present rate on pulp wood by water from Three Rivers, Quebec, the great source of supply, to Cornwall is 50 cents per ton and the railroad rate is $1.20, a saving for the water rate of 70 cents per ton; so that for 41,250 tons the annual saving would be (41,250 × 70 cents) $28,875, which, capitalized at 3 per cent, would amount to $962,500, which could be profitably spent on this improvement. The above, it will be remembered, is for raw material, requiring the use of less than one-third of the power to be developed for its manufacture into finished product. There will also be the finished product, which in case of shipment to Europe can be shipped direct to Montreal and thence abroad.

Besides the above, there is in process of construction at the village of Norfolk, on the Raquette River, 11 miles from the head of the Grasse River channel, as laid out on the map, a paper mill which will produce from 30 to 50 tons of paper per day. I am credibly informed that it is the intention of the owners of this plant to obtain their pulp wood from Lower Canada and to construct a railroad from their mill to the nearest point where they can bring their pulp wood by water, which would be Massena in case this improvement was made.

There are also near the Grasse River several deposits of excellent molding sand, which is now shipped by rail in very limited quantities on account of the cost of transportation. All of the foundries on the St. Lawrence River from Montreal to Kingston are dependent upon the United States for their supply of molding sand, Montreal alone using thousands of tons per year. Several years ago an attempt was made to ship to Montreal some of this sand by way of Grasse River, but the difficulties of navigation from the point of shipment to the mouth of the river were such that the cost was too great, and the business had to be given up. There is no doubt but that if the Grasse River is improved a business of several thousand tons per year will be done, the sand being worth about $1 per ton delivered on the boat at the point of shipment.

The traffic above described indicates but a percentage of the prospective commerce of the Grasse River, and it would seem that the expenditure of $300,000 in its improvement would produce advantages much more than equal to the cost, providing, as such improvement would, water communication with the Lower St. Lawrence of such depth as to accommodate the class of vessels which will navigate the St. Lawrence River canals.

There is submitted herewith also a map taken from the United States Lake Survey Chart, showing the part of the St. Lawrence River adjacent to the power canal, also the canal itself and Grasse River.

Very respectfully, your obedient servant,

JOHN C. CHURCHILL, Jr., *Assistant Engineer.*

Capt. GRAHAM D. FITCH, *Corps of Engineers, U. S. A.*

S S 11.

EXAMINATION AND SURVEY OF ST. LAWRENCE RIVER AT HEAD OF LONG SAULT ISLAND, NEW YORK.

[Printed in House Doc. No. 201, Fifty-sixth Congress, second session.]

Office of the Chief of Engineers, U. S. Army,
Washington, December 11, 1900.

Sir: The emergency river and harbor act approved June 6, 1900, made provision for a preliminary examination and survey of—

> Saint Lawrence River, at the head of Long Sault Island: With a view of removing the rock obstruction in the south branch of said river, so as to give a navigable depth of twenty feet of water.

In his report on preliminary examination, dated August 2, 1900 (copy herewith), the local officer, Capt. Graham D. Fitch, Corps of Engineers, stated that as the obstructions elsewhere in the St. Lawrence River are being removed to a depth of 18 feet only, and as the depth of the Massena Canal now under construction will be but 18 feet, the south channel of the St. Lawrence, at the head of Long Sault Island, is not, in his opinion, worthy of being improved so as to give a navigable depth of 20 feet of water, but that in his judgment it is worthy of being deepened to 18 feet.

The views of the local officer were concurred in by the division engineer, Col. G. L. Gillespie, Corps of Engineers, and a survey with a view of securing a depth of 18 feet was authorized.

In the report on survey, dated December 1, 1900 (also herewith), Captain Fitch states that to obtain at the locality in question a channel 150 feet wide and 18 feet deep at extreme low water would require the removal of 100,000 cubic yards of material, at an estimated cost, including contingencies, of $48,000.

Very respectfully, your obedient servant,

John M. Wilson,
Brig. Gen., Chief of Engineers,
U. S. Army.

Hon. Elihu Root,
Secretary of War.

PRELIMINARY EXAMINATION OF ST. LAWRENCE RIVER, NEW YORK, WITH A VIEW TO SECURING A NAVIGABLE DEPTH OF 20 FEET IN THE SOUTH CHANNEL AT THE HEAD OF LONG SAULT ISLAND.

United States Engineer Office,
Oswego, N. Y., August 2, 1900.

General: In compliance with the requirements of letter from your office of June 13, 1900, I have the honor to submit the following report on the preliminary examination called for by the paragraph of the act of Congress approved June 6, 1900, reading:

> Saint Lawrence River, at the head of Long Sault Island: With a view of removing the rock obstruction in the south branch of said river, so as to give a navigable depth of twenty feet of water.

The portion of the river referred to which was examined by me on July 18, lies due south of Delanys Island and of the extreme western end of Long Sault Island. It was surveyed, in connection with the survey of the Northern and Northwestern Lakes, in 1871, and is shown, though on a small scale, on detail sheet No. 3, St. Lawrence River. This shoal is about 1,300 feet long between 18-foot contours, and has a least depth, according to the above-mentioned survey, of 13 feet. There are breakers just south of it. The bottom consists probably of either hardpan, bowlders, or solid rock. Vessels navigating the St.

Lawrence River do not use this channel, and its improvement is not required by any present demands of commerce.

The desired improvement is wholly for such prospective demands of commerce as may result from the work now being done by the St. Lawrence Power Company. This company is constructing a very large power plant, to cost about $4,500,000, on the Grasse River. The water furnishing the power is to be taken from the St. Lawrence River by a canal now under construction.

This canal leaves the St. Lawrence River, opposite Long Sault Island, about 4,000 feet below the above-mentioned shoal. The canal will be 16,200 feet long, 196.5 feet wide at the water line, 18 feet deep, and have slopes of 1 on 1½. About 5,600,000 cubic yards of material must be excavated for this canal, as it passes through two ridges each over 2,000 feet long, requiring cuts of 80 and 90 feet, respectively. The average excavation per month is 225,000 cubic yards by 6 steam shovels and 4 dredges, namely, 1 dipper dredge delivering to scows which are dumped in deep water in the St. Lawrence River, 2 suction dredges with cutters operated by centrifugal pumps and discharging through pipes, and an "orange-peel" dredge emptying into an attached steel chute, whence the material, after being disintegrated by jets of water, is discharged, by means of a vacuum pump, through pipes.

The canal when finished is to have a discharge of 14,000 cubic feet per second, with a current less than 3½ miles per hour. The water in the canal at its lower terminus will be 40 feet above the ordinary water level of the Grasse River, which will form the tailrace of the plant. The bottom of the Grasse River at this point is rock, giving a good foundation for the power house, which will be of concrete and be 304 feet long, 72 feet wide, and 85 feet high. The power plant now under construction will develop 35,000 electrical horsepower, but there is provision for the future development of 40,000 additional horsepower. There will be at first seven generating units, each unit consisting of three pairs of inward-flow turbines, and a 5,000-horsepower generator on a single horizontal shaft.

Begun in 1897 and continued since 1898 by the present company, this undertaking is now about two-thirds completed and the plant is expected to be ready to supply power by May 1, 1901. Inquiries for 80,000 horsepower have already been received, and as the St. Lawrence Power Company own about 2,000 acres of ground suitable for manufacturing purposes and will be able to sell power at very low rates (from $12 to $15 per horsepower per annum, I am informed) there is no doubt that extensive manufacturing industries will be established at Massena and that these industries will create a considerable commerce of a general rather than a local character; and as the power canal, upon its completion, will connect Massena with the St. Lawrence River by a navigable channel, down which raw material from the upper river and the lakes will be brought in case this shoal is removed, the deepening of this part of the river would greatly benefit the future commerce of Massena.

As, however, the obstructions elsewhere in the St. Lawrence River are being removed to a depth of 18 feet only, and as the depth of the Massena Canal will be but 18 feet, the south channel of the St. Lawrence River at the head of Long Sault Island, is not, in my opinion, worthy of being improved so as to give a navigable depth of 20 feet of water; but it is, in my judgment, worthy of being deepened to 18 feet, and I recommend a survey to ascertain the cost of such improvement. A survey, including the necessary borings, would cost $500.

Very respectfully, your obedient servant,

GRAHAM D. FITCH,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

(Through the Division Engineer.)

[First indorsement.]

NORTHEAST DIVISION ENGINEER OFFICE,
New York, August 6, 1900.

Respectfully forwarded to the Chief of Engineers, concurring in the views of the district officer.

G. L. GILLESPIE,
Colonel, Corps of Engineers,
Division Engineer.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
August 9, 1900.

Respectfully submitted to the Secretary of War.

This is a report upon preliminary examination of St. Lawrence River at the head of Long Sault Island (full text of item quoted within), made to comply with requirements of the emergency river and harbor act of June 6, 1900.

For reasons given within, the south channel of the river at the head of Long Sault Island is not considered worthy of being improved so as to give a navigable depth of 20 feet of water, but it is considered by the local and division engineers worthy of being deepened to 18 feet.

With a view of determining the cost of improvement, I recommend that a survey be made in accordance with the within recommendation of Captain Fitch.

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

[Third indorsement.]

WAR DEPARTMENT,
August 13, 1900.

Approved as recommended by the Chief of Engineers.

ELIHU ROOT,
Secretary of War.

SURVEY OF ST. LAWRENCE RIVER, NEW YORK, WITH A VIEW TO SECURING A NAVIGABLE DEPTH OF 18 FEET IN THE SOUTH CHANNEL AT THE HEAD OF LONG SAULT ISLAND.

UNITED STATES ENGINEER OFFICE,
OSWEGO, N. Y., *December 1, 1900.*

GENERAL: In compliance with the requirements of letter from your office, of August 25, 1900, I have the honor to submit the following report on a survey of St. Lawrence River at the head of Long Sault Island, with an estimate of the cost of improving the south channel to a depth of 18 feet. The survey was made under the direct supervision of Assistant Engineer John C. Churchill, jr., whose report is transmitted herewith.

The shoal was found to be composed of hardpan, sand, gravel, and bowlders. It is 1,700 feet long between 18-foot contours, and averages about 9 feet in depth at extreme low water, and, though no soundings less than 5 feet were located, yet bowlders in many places approach to within less than 4 feet of the water surface.

The character of the bottom and the velocity of the current, which is about 5 miles per hour, render it reasonably certain that if a channel were once dredged through this shoal it would maintain its depth. An outline of the channel proposed is shown upon the accompanying map.

To obtain such a channel 150 feet wide and 18 feet deep at extreme low water would require the removal of 100,000 cubic yards of hardpan, sand, gravel, and bowlders, at 40 cents per cubic yard, amounting to $40,000, to which $8,000 should be added for contingencies.

Vessels navigating the St. Lawrence River do not use this channel, and the desire for its improvement is based wholly upon such commerce as may result from the work now being done by the St. Lawrence Power Company. This company have nearly completed, at a cost of about four and one-half million dollars, a very large electrical power plant, and will be ready early in 1901 to deliver 35,000 horsepower, which can be furnished at such low rates that manufacturing industries utilizing all the power developed will undoubtedly establish themselves in the vicinity of Massena. These industries will create a considerable commerce of a general rather than a local character, and while this commerce is as yet wholly prospective it is not, in my opinion, problematic, but assured.

Massena already has very good transportation facilities, as the New York Central and Hudson River Railroad and the Grand Trunk Railroad of Canada pass through it, while it is within a short distance of the Vermont Central Railroad and the New York and Ottawa Railroad.

The power canal, which leaves the St. Lawrence River about three-quarters of a mile below Long Sault Shoal, will, upon its completion, connect Massena with the St. Lawrence River by an 18-foot channel capable of accommodating large lake vessels. It is therefore evident that the improvement of the south channel at the head of Long Sault Island would greatly benefit the future commerce of Massena by permitting raw material to be brought by water from the Great Lakes direct to Massena.

As the obstructions elsewhere in the St. Lawrence River are being removed to a depth of 18 feet, and as the power canal will also be 18 feet deep, the south channel of the St. Lawrence River at the head of Long Sault Island is, in my judgment, worthy of being deepened by the General Government to 18 feet at an estimated cost of $48,000, and I consider this amount of improvement justified by the commerce that will be involved.

Very respectfully, your obedient servant,

GRAHAM D. FITCH,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

REPORT OF MR. JOHN C. CHURCHILL, JR., ASSISTANT ENGINEER.

United States Engineer Office,
Oswego, N. Y., November 30, 1900.

Captain: I have the honor to submit herewith my report and map[1] of a survey of the shoal near the head of Long Sault Island, St. Lawrence River, made under your direction in October and November, 1900, to ascertain the cost of a channel through the shoal 18 feet deep and of sufficient width for the passage of vessels which would probably use it.

The shoal above mentioned is 1,700 feet long and situated in the south channel of the St. Lawrence River, between the south bank of the river and the heads of Long Sault and Delanys islands.

Detail sheet No. 3 of St. Lawrence River, survey of the Northern and Northwestern Lakes, surveyed in 1871, shows a depth upon this shoal of from 12 to 14 feet; but at present, as shown by the map submitted herewith, the conditions are entirely different, the depths being from 5 to 14 feet at extreme low water, and these depths are still further limited by the presence of bowlders which in many places approach to within 4 feet of the water surface. The boat used upon this survey drew but 4 feet of water, and she struck several times during the progress of the survey, although the water was 1 foot above extreme low water.

The material composing the shoal is hardpan, sand, gravel, and bowlders, which can be dredged and deposited in the deep water eddy but a short distance above the shoal.

The current passing over it is swift, being estimated at about 5 miles per hour, and at some points it exceeds that velocity somewhat. The direction of the principal currents is such as to make the most desirable location of the proposed channel near the south bank of the river, as shown upon the accompanying map.

On account of the character of the bottom and the velocity of the current, it is my opinion that in case a channel is cut through this shoal, as indicated on the map, it will be permanent and require no further work upon it after completion.

I have estimated upon a channel width of 150 feet, that being in my judgment of sufficient width at this locality for the safe passage of vessels.

I would estimate the cost of the channel approximately as follows:

100,000 cubic yards, scow measurement, of hardpan, sand, gravel, and bowlders, at 40 cents	$40,000
Add for contingencies	8,000
Total	48,000

At present this channel is little used, and the commerce which the improvement would benefit is almost entirely prospective.

About three-quarters of a mile below this shoal is the head of the canal of the St. Lawrence Power Company, which is being constructed not only for power purposes, but also of such width and depth as to accommodate the largest class of vessels which can navigate the St. Lawrence River canals. The St. Lawrence Power Company is now developing 35,000 electrical horsepower, which will be used for manufacturing purposes upon the banks of their canal. One of the industries which it is expected will be located on the canal is a large flouring mill. To make a barrel of flour there is required approximately 5 bushels of wheat, so that for a moderate-sized mill of 500 barrels per day there would be used daily 2,500 bushels of wheat, or yearly, 750,000.

The present rate by water from Chicago to Oswego is 4 cents per bushel, and by rail 7 cents. The same proportion as to rates will obtain to points on the St. Lawrence River, and there will be at least the same difference in cost per bushel. This would be an annual saving due to the water route of 750,000 by 3 cents—$22,500—nearly half the estimated cost of this work, and there would not be required to operate this mill to exceed 200 horsepower.

The cost of transportation of freight by river and lake to and from the west is from 35 to 50 per cent less than that by railroad. It is therefore of the greatest importance to the industries to be located on the canal that the water route be opened to them which will be done if the improvement as outlined above is made.

Very respectfully, your obedient servant,

John C. Churchill, Jr.,
Assistant Engineer.

Capt. Graham D. Fitch,
Corps of Engineers, U. S. A.

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[1] Not reprinted; printed in House Doc. No. 201, Fifty-sixth Congress, second session.

APPENDIX T T.

IMPROVEMENT OF RIVERS AND HARBORS IN CALIFORNIA SOUTH OF SAN FRANCISCO.

REPORT OF CAPT. JAMES J. MEYLER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1901, WITH OTHER DOCUMENTS RELATING TO THE WORK.

IMPROVEMENTS.

1. San Diego Harbor, California.
2. Deep-water harbor at San Pedro Bay, California.
3. Wilmington Harbor, California.
4. San Luis Obispo Harbor, California.

EXAMINATION.

5. Colorado River, between El Dorado Canyon and Rioville, Nevada.

United States Engineer Office,
Los Angeles, Cal., July 15, 1901.

General: I have the honor to transmit herewith my annual reports for the works of river and harbor improvement under my charge for the fiscal year ending June 30, 1901.

Very respectfully, your obedient servant,

James J. Meyler,
Captain, Corps of Engineers.

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. A.

T T 1.

IMPROVEMENT OF SAN DIEGO HARBOR, CALIFORNIA.

At the beginning of the fiscal year a contract was in force with Healy, Tibbitts & Co., of San Francisco, Cal., for continuing the construction of the jetty along Zuninga Shoal. At that time 2,543.6 cubic yards of brush mattresses and 5,613 tons of stone had been received under this contract and used in the construction of the foundation course of the jetty, which was extended 1,033 feet farther from shore, or to a total distance of 5,025 feet. During the fiscal year 22,408 tons of stone was deposited in the work. The contract was completed October 21, 1900, on which date the high-water jetty had been extended 1,248 feet, or to a total distance of 4,595 feet from shore, and an additional 430 feet had been partially constructed.

The stone used in the work was quarried on the Coronado Islands, belonging to Mexico, and situated about 20 miles southwest of San Diego Harbor. It was delivered on barges and placed in position by means of a derrick on a separate small barge.

As the piles under the trestle which had been used under former contracts in constructing the jetty, were so badly eaten by the teredo and limnoria that many of them had been broken off and washed away by the sea, authority was obtained from the Department to remove the outer portion of the trestle, in order that the superstructure might be preserved for possible use in further extending the jetty under future contracts. An agreement was entered into with Mr. Fred Osburn, of San Diego, Cal., for removing 160 bents of the trestle, at $8 per bent, and 40 bents, a part of which had already been torn up by the contractors for the construction of the jetty, at $5.50 per bent. The contractor was required to remove all spikes, bolts, etc., and to neatly pile all material on the Government reservation. This work was completed on December 31, 1900, at a total cost of $1,445.63.

The total amount expended to June 30, 1901, including outstanding liabilities, is $268,949.65.

No increase in depth of water on the bar has been secured by the work done during the fiscal year, 22½ feet being the maximum draft that can be carried over the shoalest part of the bar at the entrance to the harbor.

The effect of the extension of the jetty has been to cause a marked erosion along the westerly extremity of North Island, and of accretion along the root of the jetty. If this continues, it may be necessary to construct bulkheads or wing dams in order to protect the westerly end of the Government reservation on the island.

The available balance, together with any additional appropriation, should be expended in extending the jetty, under contract, and to contingencies.

Mr. D. E. Hughes, assistant engineer, who was in charge of work done during the past fiscal year, performed his duties in a most able and intelligent manner.

Money statement.

July 1, 1900, balance unexpended	$58,766.39
June 30, 1901, amount expended during fiscal year	57,048.07
July 1, 1901, balance unexpended	1,718.32
Amount (estimated) required for completion of existing project	267,850.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	267,850.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897.

Amount and date of all appropriations for the work since 1875.

March 3, 1875	$80,000	August 18, 1894	$50,000
March 3, 1879	1,000	June 3, 1896	50,000
August 11, 1888	1,000	March 3, 1899	65,000
September 19, 1890	60,500		
July 13, 1892	50,000	Total	357,500

CONTRACTS IN FORCE DURING FISCAL YEAR.

The only contract in force on this work was made with Messrs. Healy, Tibbitts & Co., of San Francisco, Cal., October 16, 1899, and was approved November 2, 1899;

date of beginning work, December 10, 1899; extended to April 10, 1900, by authority of the Chief of Engineers; date of completion, November 10, 1900. Work was completed October 27, 1900.

Commercial statistics for the year the improvement began.

	Vessels.	Freight,
	Number.	*Tons.*
Entered	201	24,809
Cleared	195	11,647

The vessels, including 109 steamers, had an aggregate tonnage of 122,311 tons.

Commercial statistics for the year ending December 31, 1900.

[Furnished by the collector of customs at San Diego, Cal.]

	Incoming.	Outgoing.
Vessels:		
Steam	203	120
Sailing	44	32
Total	247	152
Tonnage	220,859	122,213
Draft, greatest ... feet	23	24½
Merchandise, general ... tons	40,112	18,157
Coal ... do	25,553	208
Cement ... barrels	11,960	....
Lumber ... feet	24,985,000	539,067
Cotton ... tons	....	5,739

	Tons.
Total amount of freight entered and cleared in 1876	36,456
Total amount of freight entered and cleared in 1900	152,777
Increase	116,321

No new lines of transportation have been established during the year.

T T 2.

DEEP WATER HARBOR AT SAN PEDRO BAY, CALIFORNIA.

On June 7, 1900, a contract for the construction of the whole breakwater was entered into with the California Construction Company, of San Francisco, Cal., for 1,985,958 tons of substructure stone, at $0.844 per ton; 221,025 tons of superstructure stone, at $3.10 per ton, and 2,370 cubic yards of concrete, at $6 per yard, or a total of $2,375,546.05. This contract was approved by the Department on June 27, 1900; time of commencement of work, August 4, 1900. The contractors chose to deliver the stone from quarries on the mainland by loading it on flat cars to be run out on a trestle built along the site of the breakwater, and depositing the stone in the breakwater either by hand or by means of a steam derrick. This necessitated the construction of 1,900 feet of single-track trestle approach from the shore to the site of the breakwater, which work was begun on July 19 at a point near the westerly extremity of the breakwater. When a small section of the trestle at this point had been built, the contractor continued its construction from both ends of this section, and also from the shore end of the trestle. The first stone was delivered on August 29, and from that time until the end of the fiscal year 190,260 tons of stone for the substructure has been delivered and placed in position, and 2,837 feet of double-track trestle has been built along the site of the breakwater. At first all stone was delivered from the granite quarries at Declez, Cal., 75 miles distant from the site of the breakwater, and of the total amount delivered during the year, these quarries have furnished 163,154 tons of stone, in sizes ranging from 100 pounds to 18 long tons. The sandstone quarries at Chatsworth Park, 57 miles distant from the site of the breakwater, have supplied 27,106 tons. The specifications require that the contractors shall, beginning with the month of March, 1901, deliver stone at the rate of 35,000 tons per month from March to November, inclusive, and at the rate of 25,000 tons per month for the remaining three months. The contractors have not yet attained the standard required, but they have thus far, with one exception, delivered a monthly total in excess of that of the previous month. The total for June, the last month of the fiscal year, was over 31,000 tons, and there is every prospect that the specification requirements will be met and passed early in the new fiscal year.

At the end of the fiscal year the following is the status of the work: From bent 0, at the westerly extremity of the breakwater, to bent 113 the substructure is practically completed, with the exception of a small amount of stone required along the ocean side of the breakwater between bents 33 and 94; from bent 113 to bent 128 both slopes are partially completed; from bent 128 to bent 172 the foundation has been laid.

There has not been sufficient breakwater constructed to serve as a protection for vessels in stormy weather; however, vessels while waiting for a favorable tide to enter the inner harbor of San Pedro are now anchoring in the lee of the 2,700 feet of the more or less built up portion of the breakwater, and captains and masters report not only a considerable protection from the southwest swell, but also a much less difficult entrance to the inner harbor in rough seas.

The total amount expended on the construction of this breakwater up to June 30, 1901, including outstanding liabilities, is $209,982.52.

The available balance, together with any additional appropriation, should be expended in extending the breakwater, under contract, and to contingencies.

Money statement.

July 1, 1900, balance unexpended	$562,607.23
Amount appropriated by sundry civil act approved March 3, 1901	146,000.00
	708,607.23
June 30, 1901, amount expended during fiscal year	133,753.89
July 1, 1901, balance unexpended	574,853.34
July 1, 1901, outstanding liabilities	24,691.20
July 1, 1901, balance available	550,162.14
July 1, 1901, amount covered by uncompleted contracts	2,454,655.57
Amount (estimated) required for completion of existing project	1,904,493.43
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	400,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

Amount and date of all appropriations for the work.

June 3, 1896	[1]$50,000
July 1, 1898	400,000
March 3, 1899	200,000
March 3, 1901	146,000
Total	796,000

CONTRACTS IN FORCE.

A contract was entered into for the completion of this breakwater with the California Construction Company, of San Francisco, Cal., on June 7, 1900, and approved June 27, 1900; date of commencement of work, August 4, 1900; date of completion, indefinite, depending on appropriations made by Congress.

COMMERCIAL STATISTICS FOR THE YEAR ENDING DECEMBER 31, 1900.

For the commercial statistics, see report of Wilmington Harbor, California.

T T 3.

IMPROVEMENT OF WILMINGTON HARBOR, CALIFORNIA.

No appropriation had been made for this harbor since 1892 until the river and harbor act of June 3, 1896, which appropriated $50,000 for improving the harbor in accordance with the project submitted February 7, 1895, and authorized the Secretary of War to enter into contracts for such materials and work as might be necessary to complete the project, not to exceed in the aggregate $342,000, exclusive of the $50,000 appropriated, but no such contracts were to be entered into until the Board provided for in the same act to determine the location of a deep-water harbor for commerce and of refuge as between Port Los Angeles, in Santa Monica Bay, and San Pedro had made its report to the Secretary of War, and not at all if such report should be in favor of San Pedro as the location of the harbor.

Owing to the proviso mentioned, no work has been done on this improvement during the fiscal year ending June 30, 1901. However, the river and harbor act of March 3, 1899, provided for a preliminary examination and survey of the inner harbor of San Pedro, thus designating this improvement under a new name. The survey was made and a report submitted on January 6, 1900, and printed in House Doc. No. 357, Fifty-sixth Congress, first session.

The total amount expended to June 30, 1901, including outstanding liabilities, is $954,497.68.

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[1] Of the appropriation of $50,000 made by river and harbor act of June 3, 1896, for deep-water harbor at Santa Monica Bay or San Pedro Bay, California, $35,855.34 was expended by the Board provided for by said act. For the full report of the Board, with its accompanying documents, see Senate Doc. No. 18, Fifty-fifth Congress, first session.

Money statement.

July 1, 1900, balance unexpended	$50,503.24
June 30, 1901, amount expended during fiscal year	.92
July 1, 1901, balance unexpended	50,502.32
Amount that can be profitably expended in fiscal year ending June 30, 1903, for maintenance of improvement, in addition to the balance unexpended July 1, 1901 Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	15,000.00

Amount and date of all appropriations for the work.

March 3, 1871	$200,000	July 5, 1884	$50,000
June 10, 1872	75,000	August 5, 1886	75,000
March 3, 1873	150,000	August 11, 1888	90,000
March 3, 1875	30,000	September 19, 1890	34,000
June 18, 1878	20,000	July 13, 1892	51,000
March 3, 1879	12,000	June 3, 1896	50,000
June 14, 1880	35,000		
March 3, 1881	33,000	Total	1,005,000
August 2, 1882	100,000		

Commercial statistics for the year the improvement began (1871).

	Incoming.	Outgoing.
Vessels:		
Steam	160	160
Sailing	65	65
Total	225	225
Freight ... tons	25,318	9,575
Lumber ... feet	10,938,336	....

Statistics of commerce for the year ending December 31, 1900.

[Furnished by the collector of customs at Los Angeles, Cal.]

	Foreign commerce. (Outer harbor.)		Domestic commerce.	
	Incoming.	Outgoing.	Incoming.	Outgoing
Vessels:				
Steam	6	....	310	310
Sailing	1	1	191	191
Total	7	1	501	501
Tonnage	4,894	352	170,157	170,157
Draft, greatest ... feet	14	14	19	19
Merchandise, general ... tons	877	....	5,976	2,047
Lumber ... feet	....	....	110,994,062	....
Crude oil ... barrels	....	....	....	187,800

	Tons.
Total amount of freight entered and cleared in 1871	50,059
Total amount of freight entered and cleared in 1900	253,855
Increase	203,796

No new lines of transportation have been established during the year.

T T 4.

IMPROVEMENT OF SAN LUIS OBISPO HARBOR, CALIFORNIA.

At the beginning of the fiscal year a contract was in force with A. A. Polhamus, of San Diego, Cal., for furnishing and placing in position on the line of the breakwater 31,000 tons of stone at $1.66 per ton. At that time 12,888 tons had been delivered under this contract, and the status of the work was as follows: 1,091 feet, including Whaler Island, had been completed up to grade, 6 feet above high water, 280 feet up to and above high water, and 400 feet from foundation layer to high water. During the fiscal year the contractor delivered 18,180 tons of stone from the quarry at Morro Rock, which is about 22 miles north from the breakwater. For this work he had in use one seagoing tug, 3 barges of a capacity of about 250 tons each, and 1 floating derrick for use in placing stone. The contract was finished September 29, 1900, and the breakwater had then been built up as follows: 1,326 feet, including Whaler Island, completed up to grade, 6 feet above high water, 235 feet up to and above high water, and 220 feet in foundation layer and up to high water. The total length of the structure when completed will be 1,981 feet.

As a result of the expenditure made during the past fiscal year, steamboat men calling at this port report a marked increase in the protection afforded their boats from the southwest swell.

The total amount expended to June 30, 1901, including outstanding liabilities, is $228,799.06.

The available balance, together with any additional appropriation, should be expended in extending the breakwater, under contract, and to contingencies.

Money statement.

July 1, 1900, balance unexpended	$41,544.66
June 30, 1901, amount expended during fiscal year	40,343.72
July 1, 1901, balance unexpended	1,200.94
Amount (estimated) required for completion of existing project	338,660.00
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	150,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

Amount and date of all appropriations for the work.

August 11, 1888	$25,000
September 19, 1890	40,000
July 13, 1892	30,000
August 18, 1894	40,000
June 3, 1896	40,000
March 3, 1899	55,000
Total	230,000

CONTRACT IN FORCE DURING FISCAL YEAR.

The only contract in force on this work was made with Capt. A. A. Polhamus, of San Diego, Cal., July 29, 1899, and approved August 17, 1899; date of beginning work, August 3, 1899; date of completion, September 30, 1900. Work on this contract was completed September 29, 1900.

COMMERCIAL STATISTICS.

[Statistics furnished by the Pacific Coast Railway Company.]

	Year the improvement began, 1888.		Year ending December 31, 1900.	
	Incoming.	Outgoing.	Incoming.	Outgoing.
Vessels:				
Steam	603	603	382	382
Sailing	34	34	2	2
Total	637	637	384	384
Tonnage	452,149.34	452,149.34	322,600	322,600
Draft, greatest ....feet	18	18	18	....
Merchandise, general ....tons	8,802	5,669	5,784	473
Coal ....do	2,985	....	391	....
Lumber ....feet	8,884,400	....	2,334,625	....
Grain ....tons	....	23,305	....	19,692
Bituminous rock ....do	....	15,342	....	3,451
Dairy products ....do	....	....	....	947
Live stock ....do	....	....	....	93

	Tons.
Total amount of freight entered and cleared in 1888	68,425
Total amount of freight entered and cleared in 1900	35,499
Decrease	32,926

No new lines of transportation have been established during the year.

T T 5.

PRELIMINARY EXAMINATION OF COLORADO RIVER BETWEEN EL DORADO CANYON AND RIOVILLE, NEVADA.

[Printed in House Doc. No. 67, Fifty-sixth Congress, second session.]

Office of the Chief of Engineers,
United States Army,
Washington, November 20, 1900.

Sir: I have the honor to submit herewith, for transmission to Congress, copy of report dated September 29, 1900, by Capt. James J. Meyler, Corps of Engineers, upon preliminary examination authorized by the emergency river and harbor act approved June 6, 1900, of Colorado River between El Dorado Canyon and Rioville, Nev., with a view to the extension of navigation to Rioville.

Very respectfully, your obedient servant,

John M. Wilson,
Brig. Gen., Chief of Engineers,
U. S. Army.

Hon. Elihu Root,
Secretary of War.

REPORT OF CAPT. JAMES J. MEYLER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Los Angeles, Cal., September 29, 1900.

GENERAL: In compliance with circular letter dated Office Chief of Engineers, June 13, 1900, I have the honor to submit the following report of preliminary examination of Colorado River between El Dorado Canyon and Rioville, Nev., with a view to the extension of navigation to Rioville.

This portion of the river has been examined and reported upon before. The late Lieut. Col. W. H. H. Benyaurd, Corps of Engineers, made a report in 1888 of a preliminary examination of the Colorado River from Camp Mohave to the State line between Nevada and Utah, and in 1895 Lieut. (now Capt.) C. L. Potter, Corps of Engineers, submitted a report of a preliminary examination of the river between the mouth of the Virgin River and Yuma, Ariz. Attention is respectfully invited to each of those reports, which are to be found in the Annual Reports of the Chief of Engineers for the years 1889 and 1896, respectively, the former on pages 2481–2482 and the latter on pages 3186–3187.

Because of the information to be found in these reports and the conclusive opinions presented therein, and also that to be found in the reports of the exploring expeditions of the Colorado River under Lieutenant Ives and Captain Wheeler, I did not at first consider it necessary that an examination should be made of the stretch of river in question. However, after communicating by letter with some eight or ten of those most deeply interested in the prospective improvement of this part of the river, I decided that it would be desirable to have one of my assistants make a trip over the river from Rioville, Nev., to Needles, Cal., when the stage of water should be most favorable for an examination of the stream. In compliance with instructions from me, Mr. L. C. Easton, of this office, made the trip over the river during the latter part of this month, and the report of his examination is appended herewith.

The Grand Canyon of the Colorado terminates about 35 miles above Rioville, and that portion of the river from the foot of the Grand Canyon to the Gulf, about 600 miles in length, is very largely valley river, as distinct from that which flows through the canyons. The valley river is made up of a network of shallow and ever-shifting channels, separated by broad sand bars and scattered over an ill-defined width, in which changes of great extent and rapidity are continually going on. The canyon river flows between permanent banks, its waters are generally confined to a single channel, and its obstructions consist usually of cobble and bowlder bars with their attendant swift rapids, and occasional large bowlders and isolated rocks. From the very nature of the valley river no permanent improvement could be attempted except at enormous cost; in the canyon river the improvement of the short and shoal rapids, which must generally be attended by the removal of a portion of the cobbles and bowlders underlying them, can only be done at the risk of developing new obstructions, by changing the slope and elevation of the low-water surface of the river above them. In either case, then, the improvement of any portion of the river can only be hoped for at great cost.

The stretch of river in consideration, from El Dorado Canyon to Rioville, is almost entirely in canyon. Its general characteristics are those of a narrow, winding stream, its current is generally swift, its bottom of gravel and cobble, and its banks of gravel and bowlder bars or precipitous bluffs of stone. On the whole, it presents a fixed regimen. During the high-water stages, however, it assumes many of the characteristics of a mountain stream; its slope is excessive, and confined as it is between the perpendicular bluffs on either side, its current is very irregular, being of generally high velocity over the rapids, though much gentler in the pools between them. During low water, navigation is difficult because of the shoal rapids and the numerous large bowlders and rocks that obstruct the channel, while at high water it is dangerous because of the swift current caused by an irregular cross section and excessive fall.

The distance by river from El Dorado Canyon to Rioville is variously estimated at from 65 to 75 miles, and the difference in elevation of the water surface at those points, as given by barometric readings, taken by Lieut. E. Bergland, Corps of Engineers, in 1875, is 270 feet, which would make the average fall per mile about 4 feet. That for the stretch of river immediately below El Dorado Canyon was found by Lieut. A. H. Payson, Corps of Engineers, in 1878–79, to be 2.03 feet per mile. In this lower section not more than 10 or 12 rapids are to be found in a distance of about 70 miles, and in view of the fact that in a similar distance above El Dorado Canyon 42 such rapids are encountered it is not surprising that the fall per mile in the upper stretch is double that of the lower section.

The mountainous country bordering this section of the river is as a rule absolutely barren, though portions of it are said to be rich in mineral wealth. In his examination, Mr. Easton found but one small tract of land under cultivation, namely, that belonging to Mr. Bonelli, at Rioville. The interests involved are therefore only those pertaining to the development of the mines along the banks. Many discoveries and locations of such mines are reported, but none of them have yet been opened up and established on a permanent basis. Previous to 1887, when salt was brought down from the mouth of the Virgin River for reduction purposes in a silver mine at El Dorado Canyon, Capt. J. A. Mellon, the oldest navigator on the river, had made 39 trips to Rioville during high-water stages of the river. Nineteen of these trips were made during the high-water seasons of 1880 and 1881, with a sloop drawing about 2 feet and carrying about 18 tons. The other 20 trips were made between 1879 and 1887, with a steamer 178 feet long, 36 feet beam, and about 30 inches draft, carrying about 60 tons. Since 1887, when the silver mine at El Dorado Canyon was closed down, not a single trip has been made by steamer above that point. High-water navigation to points between El Dorado Canyon and Rioville is still possible during about three months in each year, and it seems to me that were the demands of the mining interests sufficiently great, and were there enough freight to pay for the trouble, the steamers would still make regular trips along the stretch of river under consideration as long as the high-water stages of the river during each year would permit of it.

The section of the river below El Dorado Canyon to Camp Mohave is very similar in its general characteristics to that of the stretch between this canyon and Rioville. In 1878–79 a survey was made from Camp Mohave to El Dorado Canyon, and an estimate of $85,000 was submitted for its partial improvement. No work was done, however, until 1884, when $25,000 was appropriated, and this sum was expended during the following two seasons in removing obstructions and improving certain rapids and bars between the points indicated. The work was not continued, as the officer in charge did not ask for additional funds, because he was of the opinion that the commercial interests involved did not warrant the expenditure of the amount of money required to give low-water navigation during the entire year. The average fall of the river from El Dorado Canyon to Camp Mohave is about 2 feet per mile, while, as near as can be determined from information at hand, it is about 4 feet per mile for that portion between El Dorado Canyon and Rioville. Nevertheless, it is thought that a partial improvement of this upper section would be both feasible and practicable. The removal of the obstructions mentioned in Mr. Easton's report would simply insure high-water navigation to Rioville with greater safety than at present. To secure low-water navigation to that point for the greater part of the year would involve improvements on a much larger scale and at much greater cost.

The river and harbor act which provides for this examination states that it shall be made with a view to extending navigation to Rioville. High-water navigation is already possible to that point; low-water navigation is possible to El Dorado Canyon for about eight months in the year. To extend a similar low-water navigation to Rioville could not possibly be done by the expenditure of any reasonable amount and only at a cost that would be out of all proportion to the benefits to be derived from such improvements.

I am, therefore, of the opinion that the Colorado River between El Dorado Canyon and Rioville is not worthy of improvement by the General Government.

Very respectfully, your obedient servant,

James J. Meyler,
Captain, Corps of Engineers.

Brig. Gen. John M. Wilson,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. Engineer Office, Pacific Division,
San Francisco, Cal., October 3, 1900.

Respectfully forwarded to the Chief of Engineers, United States Army.

The opinion of the district engineer, that the Colorado River between El Dorado Canyon and Rioville is not worthy of improvement by the General Government, is concurred in.

S. M. Mansfield,
Colonel, Corps of Engineers,
Division Engineer.

[Second indorsement.]

Office Chief of Engineers,
U. S. Army,
October 25, 1900.

Respectfully submitted to the Secretary of War, concurring in the opinion of the local engineer officer and of the division engineer that improvement of the locality by the General Government in the manner indicated by the act authorizing the examination is not advisable.

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

[Third indorsement.]

WAR DEPARTMENT,
October 27, 1900.

The views of the local officer and of the division engineer, as concurred in by the Chief of Engineers, are approved.

ELIHU ROOT,
Secretary of War.

REPORT OF MR. L. C. EASTON, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Los Angeles, Cal., September 27, 1900.

CAPTAIN: In compliance with your instructions to proceed to Rioville, Nev., and examine the Colorado River from Rioville to El Dorado Canyon, Nevada, with a view to the extension of navigation to Rioville, I have the honor to report as follows:

I left Los Angeles on the evening of the 15th instant, and proceeded to Kingman, Ariz., by railroad, and drove from there to Temple Bar, a point on the Colorado River 12 miles above Rioville, as this was the most accessible point on the river to be reached by team. I arrived at Temple Bar on the evening of the 17th and proceeded down river by skiff the next morning, arriving at El Dorado Canyon on the morning of the 19th, and at Needles, Cal., on the morning of the 22d, whence I returned to Los Angeles by railroad.

Rioville is at the confluence of the Virgin and Colorado rivers, the former a stream flowing from the north, and carrying but little water (saline) at its low stage. The Colorado River, as is well known, is formed by the junction of the Grand and Green rivers, and it drains the enormous area of over 240,000 square miles. It is in flood during June and July, and is then fed principally by the melting snows on the mountains at its source. Between Rioville and El Dorado Canyon the river is in canyon all the way, with high, permanent banks, close together, which give a permanent, definite channel in all cases, except perhaps from the mouth of the Vegas Wash, for a distance of about 2 miles, where the permanent banks are from half to three-quarters of a mile apart and the river is divided into small channels by numerous sand bars. At Rioville, what is known locally as the Sacramento Valley reaches down to the left bank of the river from a summit of over 3,300 feet elevation 50 miles to the southward. The river banks here are high cobble and gravel bars, changing to rocky promontories until the river enters the Black Mountain Range in what is known as Bowlder Canyon. Here the walls of eruptive or metamorphic stone rise perpendicularly, or nearly so, to great height, broken at intervals by small side canyons or washes. On leaving Bowlder Canyon, through which it flows for about 10 or 11 miles, the river reaches the more open country of the Callville and Vegas washes, where the high gravel bar is of more frequent occurrence than the rocky ledge. Twelve miles below the mouth of Bowlder Canyon the river enters Black Canyon, whose walls are more broken by side canyons and are more open than in Bowlder Canyon. Five miles below Black Canyon is El Dorado Canyon. This last stretch of the river has the high cobble and gravel bars, but they recede more from the water's edge, having sloping sand and gravel bars in front of them in many places.

Rioville is a post-office and stage station on the route between St. Thomas, Nev., and Chloride, Ariz. It contains but one residence, belonging to Daniel Bonelli, who raises hay, etc., on the bottom lands along the Virgin River. From Rioville to El Dorado Canyon the land is barren and uninhabited. It is, however, rich in mineral wealth, and numerous monuments, marking corners of mineral claims, were seen along the river bank. Most of these claims could only be worked from the river, as the side canyons are generally inaccessible from the land side. The salt deposits in the Virgin Valley were in demand before the silver mines at El Dorado Canyon shut down. Deposits of gypsum, mica, and sulphur were also found. I am informed that at the head of Bowlder Canyon an immense amount of manganese ore, some of it running as high as 50 per cent manganese, has been located, and that the records of this mining district (St. Thomas) alone show upward of 350 claims located, many of which cover copper ores of 20 to 30 per cent. Alum is also reported as part of the mineral wealth of this section. At Temple Bar a mining company has put in an elaborate plant for mining gold in the gravel deposits there, and many tons of copper ore, I am told, are hauled 91 miles to railroad connection in Utah from mines near the mouth of Grand Canyon. The commerce of the river above El Dorado Canyon is practically nothing, all the freight for either Rioville or Temple Bar being hauled by team from the railroad terminus at Chloride, Ariz., a distance of over 60 miles, at a cost of $20 per ton. This traffic is small, and I was unable to obtain any definite figures in regard to it.

Capt. J. A. Mellon, previous to 1887, and at the high-water stage of the river, made 20 trips from El Dorado Canyon to Rioville with a steamer 178 feet over all, 36 feet beam, and 30 inches draft, with 60 tons of freight, and 19 trips with a sloop of 56 feet keel, 15 feet beam, and 2 feet draft, with 18 tons of freight. This sloop was lost on a bowlder in Short and Dirty Rapids. No vessel has ascended the river above El Dorado Canyon since 1887 on account of lack of freight.

The distance from Rioville to El Dorado Canyon is approximately 65 miles, called 75 miles by steamboat men, and the fall of the low-water surface 270 feet, as determined by the barometric observations of Lieutenant Bergland, Corps of Engineers, 1875. This would give an average fall of approximately 4 feet per mile. Lieut. A. H. Payson, Corps of Engineers, estimated the extreme low-water discharge at Camp Mojave in 1879 to be not over 3,000 cubic feet per second. Other estimates were greatly in excess of this. (See p. 1777, Chief of Engineers' Report, vol. 2, 1879.)

In the 65 miles there are 42 rapids, where the shallowness of the water (2 to 4 feet at the crest of the rapids), combined with the velocity due to its slope, serves to make a difficult crossing for a steamboat ascending the river. In the pools between the rapids are included all places where there may be considerable slope of the surface of the water, but where the depth of water is great enough to class it as "swift water" only. An attempt to deepen the water at these shoal places in order to get low-water navigation from El Dorado Canyon to Rioville would prove to be very expensive, but the time of navigation could be lengthened to five or six months of the year at moderate cost by the removal of certain dangerous obstructions, consisting of rocky ledges or bowlders or of bars formed of sand, gravel, and bowlders washed down the side canyons or washes by the flood waters of storms in the mountains above. These floods must have occurred when the rainfall in this section was more abundant than at present, as Captain Mellon, the oldest navigator on the river, tells me that these obstructions have remained unchanged for the last thirty-six years. It would seem, therefore, that their removal would give permanent relief, and I think this could be done without materially increasing the cross section of the river at these points and thus lowering the pools above and revealing new obstructions to navigation.

Of the 42 rapids mentioned above there are at least 8 that would be dangerous to navigate at the stage of water at which I made the examination—30 inches above the lowest observed in several years past.

Rapid No. 5 (½ mile below Stones Ferry).—Has a line of cemented gravel bowlders stretched along its crest, some visible above the water's surface and some submerged. Twelve to 15 of these bowlders should be broken up with powder and removed. A number of rafts have been wrecked here.

Rapid No. 12 (2½ miles from entrance to Bowlder Canyon).—Is full of bowlders, all submerged, but 3 or 4 large ones are very near the surface. These bowlders should be removed.

Rapid No. 27 (¼ mile below Warm Spring Rapids).—The banks here are high and steep, but a gravel bar on the left bank throws the current to the right bank. It is here intercepted by a ledge of rock extending out into the stream 50 feet from the right bank and 8 feet above the water's surface, making a sharp, dangerous turn and bad eddies. The crest of bar has a very hard bottom. This ledge of rock should be removed.

Short and Dirty Rapids, Nos. 28 and 29.—There are two rapids 250 to 300 yards apart. The first is formed by a rocky ledge on the right bank and a sand and bowlder bar on the left bank contracting the current and inclining it to the right bank. It then strikes a sand and bowlder bar on the right bank, forcing the current to a large bowlder probably 50 feet out in the stream from the left bank, and is again contracted. The sloop *Southwester*, belonging to the Southwestern Mining Company, was wrecked on this bowlder. A strip of the upper bowlder bar should be removed, and the large bowlder and a small strip of the lower bowlder bar should also be removed to straighten the rapids.

Crooked Rapids, No. 34.—A sand and cobble bar on the left bank throws water to the right bank; here it strikes a rocky ledge. Opposite this ledge, in the middle of the channel, is a low cobble bar which divides the stream, the main channel passing between the ledge and bar by a sharp turn to the right. The outer end of the upper cobble bar should be removed, and the cobble island should be loosened up with powder, when it would be carried away on the rise of the river, making a straight crossing.

Rapid No. 36 (½ mile above Roaring Rapids).—A gravel reef extending diagonally upstream from the left bank throws the current to right bank, where it strikes a rocky ledge projecting 50 feet into the water from the right bank. As the river bends to the left at this point, the current rushes against the ledge with great force. This rocky ledge should be removed. Perhaps a survey would show it to be more practicable to dam up the present channel on the right bank, at the head of the rapid, throw the water to the lower end of the reef, and help it with dynamite to break through this gravel near the left bank.

Roaring Rapids, No. 37.—Formed by bowlders on both banks, greatly contracting the current and throwing it toward the left bank, where 100 yards or more from crest of rapids is a pinnacle rock projecting 12 feet above water. A strip of the bowlder bar on the right bank should be removed. The pinnacle rock should also be removed.

There are also several isolated bowlders in the channel at other points that should be removed. This could be done with little trouble, as they are located in comparatively smooth water.

I give below the lowest and highest reading for each month since Februry, 1899, of a river gauge at Temple Bar. The gauge stood at 2 feet at the time this examination was made.

	1899.				1900.			
	Lowest.		Highest.		Lowest.		Highest.	
	Ft.	*in.*	*Ft.*	*in.*	*Ft.*	*in.*	*Ft.*	*in.*
January	.....	.....	.....	.....	0	6	1	2
February	0	10	1	9	0	10	1	2
March	1	5	1	9	1	0	8	0
April	1	4	6	2	2	5	4	6
May	5	1	12	6	4	0	12	4
June	10	10	15	10	7	10	14	10
July	6	8	18	10	2	10	7	10
August	3	4	8	8	2	0	2	6
September	2	0	8	2	—0	6	4	2
October	1	4	3	8	.....	.....	.....	.....
November	2	3	2	6	.....	.....	.....	.....
December	0	8	1	2	.....	.....	.....	.....

The highest recorded reading on this gauge was 21 feet 10 inches, on May 31, 1897, and the lowest 6 inches below the zero of the gauge, on September 4, 1900. The river leaves no high-water marks on its banks. In the narrowest parts of the canyons, however, driftwood was found in one or two places lodged as high as 50 feet above the water surface of the river.

The portion of the river between El Dorado Canyon and Needles, over which a large proportion of the upper river commerce must necessarily pass, is in such bad condition that the steamer *Cochan*, 159 feet over all, 32 feet 8 inches beam, and 16 inches light draft, the only steamer carrying freight above Needles, can navigate from Needles to El Dorado Canyon only eight or nine months in the year, and sometimes only with great difficulty.

In view of this fact and also of the absence of any commerce on the river between El Dorado Canyon and Rioville, I do not think this portion of the river worthy of improvement.

I wish to make acknowledgment of the services of Capt. J. A. Mellon, who accompanied me on my trip down the river, and whose long experience and knowledge of the river proved an invaluable assistance.

Very respectfully, your obedient servant,

L. C. Easton, *Assistant Engineer.*

Capt. James J. Meyler,
Corps of Engineers, U. S. A.

APPENDIX U U.

IMPROVEMENT OF ALVISO, SAN FRANCISCO, AND OAKLAND HARBORS, CALIFORNIA, OF SAN JOAQUIN AND SACRAMENTO RIVERS AND THEIR TRIBUTARIES, OF RIVERS AND HARBORS IN CALIFORNIA NORTH OF SANFRANCISCO, AND OF PEARL HARBOR, HAWAII.

REPORT OF LIEUT. COL. W. H. HEUER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1901, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Alviso Harbor, California.
2. San Francisco Harbor, California.
3. Oakland Harbor, California.
4. San Joaquin River, California.
5. Mokelumne River, California.
6. Sacramento and Feather rivers, California.
7. Napa River, California.
8. Petaluma Creek, California.
9. Humboldt Harbor and Bay, California.
10. Pearl Harbor, Hawaii.
11. Removing sunken vessels or craft obstructing or endangering navigation.

EXAMINATIONS AND SURVEYS.

12. Oakland Harbor, California.
13. San Joaquin River, California, and waterways connecting the same with Strait of Karquines.
14. San Joaquin River, California, above the mouth of the Stanislaus, with a view to closing blind sloughs, especially Finegan, Amphlet, and Walden sloughs.

HARBOR LINES.

15. San Francisco Harbor, California.

United States Engineer Office,
San Francisco, Cal., July 9, 1901.

General: I have the honor to transmit herewith my annual reports for the fiscal year ending June 30, 1901.

Very respectfully, your obedient servant,

W. H. Heuer,
Lieut. Col., Corps of Engineers.

Brig. Gen. G. L. Gillespie,
Chief of Engineers, U. S. A.

U U 1.

IMPROVEMENT OF HARBOR AT ALVISO, CALIFORNIA.

A description of this harbor and the project for its improvement was published in the Annual Report of the Chief of Engineers for 1900, page 4213.

REPORT OF OPERATIONS FOR THE FISCAL YEAR ENDING JUNE 30, 1901.

Work under the contract entered into with A. C. Aiken on May 25, 1900, was commenced on August 23, 1900, with a small clam-shell dredge, but progressed very slowly. In November a suction dredge was put to work, but this also proved incapable of dredging the hard material which was encountered. This was replaced at the end of December by a powerful dredge which had just been built, with which work was continued until June 19, 1901, when it was completed.

During the work 166,263 cubic yards of material were removed and placed on shore. The price paid was 14.48 cents per cubic yard. The material encountered was very hard and difficult to dig, causing much delay and many and costly repairs to the machinery.

During the fiscal year there was spent on this work $25,833.71, making a total expended on this improvement to June 30, 1901, of $26,378.09.

The finishing of the work of dredging completes the project as adopted by Congress, and leaves a channel 7 feet deep at low water and 60 feet wide, excepting in front of the wharves where it is 80 feet wide, with a V-shaped turning basin at the upper end of the slough. This width and depth is ample for the limited commerce which is carried on this slough.

The work was in local charge of Inspector W. J. Rust, whose services were very satisfactory.

Money statement.

July 1, 1900, balance unexpended	$47,455.62
June 30, 1901, amount expended during fiscal year	25,833.71
July 1, 1901, balance unexpended	21,621.91
July 1, 1901, outstanding liabilities	457.50
July 1, 1901, balance available	21,164.41

List and dates of all appropriations for improving harbor at Alviso, Cal.

March 3, 1899	$48,000

ABSTRACT OF ALL CONTRACTS IN FORCE FOR IMPROVING HARBOR AT ALVISO, CAL.

Contract dated May 25, 1900, for dredging a channel in Alviso Slough, California.

[At 14.48 cents per cubic yard.]

Name of contractor.	Date of approval.	Work commenced.	Work completed.
A. C. Aiken	June 18, 1900	Aug. 23, 1900	June 19, 1901

COMMERCIAL STATISTICS.

The commerce of Alviso Slough is carried on one stern-wheel steamer (the *F. M. Smith*, 295 tons gross tonnage), which makes daily trips, Saturdays excepted. from San Francisco to Alviso and return. During the year 1900, however, she was taken off the route on October 3, and was not again run during the year, because, it was reported, she did not pay her expenses—about $65 per day.

The following is a statement of the freight and passengers carried by her during the year 1900:

General freight	tons..	7,839
Passengers		21,840

Scow schooners occasionally carry lumber and coal into this slough, but no estimate of their business can be obtained.

U U 2.

IMPROVEMENT OF HARBOR AT SAN FRANCISCO, CALIFORNIA.

The work at present being done in San Francisco Harbor, California, consists in the removal of Arch and Shag Rocks, which was provided for in the river and harbor act of March 3, 1899, as follows:

> Improving San Francisco Harbor, California: By removing Arch Rock and Shag Rocks Numbered One and Two, all to a depth of thirty feet below mean low water, according to the report made October thirteenth, eighteen hundred and ninety-seven, one hundred thousand dollars: *Provided*, That the Secretary of War may enter into a contract or contracts for the material and work necessary for the completion of said project, to be paid for as appropriations may from time to time be made by law, not to exceed in the aggregate five hundred thousand dollars, exclusive of the amount herein appropriated.

The sundry civil act of June 6, 1900, appropriated for the work $170,000.

A description of these rocks was printed in the Annual Report of the Chief of Engineers for 1898, pages 2923 to 2926.

The work of rock removal is being done by contract with Mr. Rudolf Axman for $253,500. As the aggregate amount of rock to be removed above the 30-foot plane is 31,931 cubic yards, it makes the removal cost the Government $7.93 per cubic yard.

At the close of the last fiscal year, June 30, 1900, Shag Rock No. 1 had been blown up and shattered. A description of the method used in drilling, loading, and firing the blast was printed in the preceding annual report. However, all the broken rock above the grade plane (30 feet below low water) had not been removed. This work was completed on July 30, 1900, by means of a large clam-shell dredge, aided by a little surface blasting.

Work was then commenced on Shag Rock No. 2, the crest of which was 17 feet below low-tide level. The volume of this rock above the 30-foot plane measured 2,979 cubic yards. The rock was broken and shattered entirely by surface blasting, done by placing nitro-gelatine in bags haphazard over the surface of the rock, loaded down and held in position by bags of sand, and then exploding it by means of an electric battery. The largest charge fired at any one time was 21,169 pounds, September 5, 1900. It lifted a column of water 1,106 feet high and 240 feet in diameter. Numerous other blasts were fired at various times afterwards, making the aggregate of explosive used in the removal of this rock 51,007 pounds. Thereafter the large clam-shell dredge removed, in 68 working days, at irregular intervals, the broken rock, amounting to 2,979 cubic yards. The dredge was actually employed by the contractor on this work during 142 working days, at an estimated expense of $13,900. This would make the dredging alone cost the contractor $4.66 per cubic yard. The rate of removal by the dredge was 43.8 cubic yards per working day of 20 hours, or 2.19 cubic yards per hour.

The process of rock removal by surface blasting on this rock was slow, exceedingly expensive, and unsatisfactory.

The required depth (30 feet below low water) was finally obtained on April 5, 1901, and was determined by carefully sweeping over the rock at slack water of several tides and final complete survey before acceptance. As the rock was fully 1½ miles from the shore, the method of making the final survey, which was novel, is illustrated in the photograph herewith. Photographs of the explosion of the rock are also sent.

Work on Arch Rock was begun on September 15, 1900. A platform resembling a wharf, whose deck is about 9 feet above high-tide level, is built on wooden piles. It surrounds and is fastened to the pinnacle of the rock, which is about 30 feet above low-tide level. The platform covers an area of about 33,722 square feet. Steam drills are placed on this platform, and holes about 18 feet apart and 10 inches in diameter are drilled to a depth of about 5 feet below the level of the grade plane. The drills are operated by steam furnished from a boiler on a large scow which is moored alongside the drilling platform. On June 30, 1901, 171 holes had been drilled, of an aggregate depth of 2,478 feet, spaced as shown in tracing herewith. The average rate of drilling per drill is about 9 feet per twenty-four hours when working continuously.

During the past fiscal year the sum of $52,181.31 has been expended, making the total expenditure to June 30, 1901, $55,511.14.

The work was in local charge of Assistant Engineer H. L. Demeritt, assisted by Inspectors H. J. Spotts and William Kerlinger, whose services have been well rendered.

Money statement.

July 1, 1900, balance unexpended	$266,670.17
June 30, 1901, amount expended during fiscal year	52,181.31
July 1, 1901, balance unexpended	214,488.86
July 1, 1901, outstanding liabilities	285.00
July 1, 1901, balance available	214,203.86
July 1, 1901, amount covered by uncompleted contracts	205,118.26

List of all appropriations for improving harbor at San Francisco, Cal.

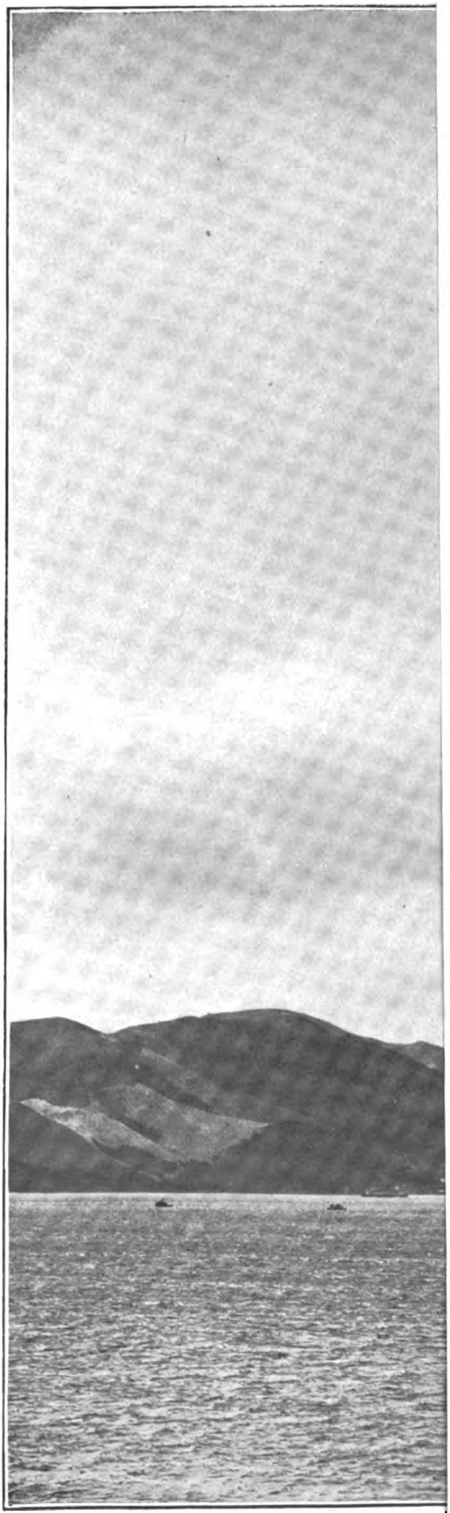
March 3, 1899	$100,000
June 6, 1900	170,000
Total	270,000

LIST OF ALL CONTRACTS IN FORCE FOR IMPROVING HARBOR AT SAN FRANCISCO, CAL.

Contract dated September 14, 1899, for removing rocks in San Francisco Harbor, California.

[For $258,500.]

Name of contractor.	Date of approval.	Work commenced.	Work completed.
Rudolf Axman	Sept. 29, 1899	Dec. 8, 1899	Work in progress.



EXPLOSION OF SURFACE BLAST ON SHAG RO

Quantity of explosive, 21,169 pounds of nitrogelatin

COMMERCIAL STATISTICS.

Tonnage movement of commercial vessels entering and leaving San Francisco Harbor during the year 1900, collected and furnished by the secretary of the San Francisco Merchants' Exchange:

		Tons.
Arrivals:		
From domestic ports, steam		1,147,451
From domestic ports, sail		492,932
Total		1,640,383
From foreign ports, steam	958,122	
From foreign ports, sail	427,464	1,385,586
Total arrivals		3,025,969
Departures:		
To domestic ports, steam	1,124,657	
To domestic ports, sail	467,819	1,592,476
To foreign ports, steam	973,150	
To foreign ports, sail	422,085	1,395,235
Total arrivals and departures		6,013,680

The above statement of the tonnage entering and leaving San Francisco Harbor only includes the commercial vessels, and not the large number of United States and foreign Government vessels which visit the port. There are also a number of ferry boats plying in San Francisco Harbor, carrying much freight and enormous numbers of passengers, and a large number of trading boats carrying freight to the small landings adjacent to the bay.

Grand total customs receipts for 1900, $7,963,342.

U U 3.

IMPROVEMENT OF OAKLAND HARBOR, CALIFORNIA.

Full details of original depth, width of channel, and commercial availability, together with the original project of 1874, and all important modifications and additions, can be found in the Annual Report of the Chief of Engineers for 1897, page 3327.

REPORT OF OPERATIONS FOR THE FISCAL YEAR ENDING JUNE 30, 1901.

During the fiscal year the sum of $170,135.98 has been spent, making a total expenditure to June 30, 1901, on this improvement of $2,115,061.96.

At the beginning of the year contracts were in force for building a highway bridge across the tidal canal at High street, for a combined railroad and highway bridge at Fruitvale avenue, and for making an artificial channel to divert the waters of Sausal Creek away from the tidal canal.

The High Street Bridge was completed and accepted on September 20, 1900. The diverting channel for Sausal Creek was completed on October 4, 1900. The Fruitvale Avenue Bridge was completed on January 26, 1901, with the exception of the mechanical device for lifting the ends of the bridge from the rest piers. This did not work satisfactorily, as required in the contract, and the retained 10 per cent payment has been withheld until the bridge shall be accepted.

Photographs of these bridges over the tidal canal are sent herewith.

The wooden roadway of the Park Street Bridge across the tidal canal became so much worn from heavy traffic thereon that it had to be replaced by wooden blocks laid in asphalt. The work was done by contract and was completed in October, 1900, at a cost of $2,357.

In October, 1900, the boathouse was moved from its site near Webster Street Bridge to a new locality at the inshore end of the south jetty.

Negotiations with the Southern Pacific Company, with a view to obtaining a release from building a combined railway and highway bridge across the tidal canal at Washington avenue, were completed on April 4, 1901, by the payment of the $50,000 consideration agreed upon. This release opened the way for completing the tidal canal. The work was therefore advertised, and bids opened on May 22, 1901. The lowest bidder was the Atlantic, Gulf and Pacific Company, at 19.74 cents per cubic yard. Contract with that company was entered into on June 15, 1901, but the work has not yet been commenced.

The emergency river and harbor bill of June 6, 1900, directed an examination and survey of—

> Oakland Harbor, with a view to the improvement of said harbor to meet the needs of present and prospective commerce from the western end of the tidal canal to deep water in San Francisco Bay, including the excavation of a tidal basin.

The examination was made, and to determine the character of the bottom 337 borings were made, 5 inches in diameter, to a depth of 30 feet below the low-water plane. The aggregate depth of the holes was 7,437 feet.

The work was done after public notice, at a cost of 37½ cents per linear foot, and was completed on December 12, 1900. Report of the survey and examination, with estimate of cost, was submitted to Congress by the Secretary of War on December 28, 1900, and is printed as House Doc. No. 262, Fifty-sixth Congress, second session.

The work was in local charge of Assistant Engineer L. J. Le Conte, assisted by Inspectors J. A. Graham, W. J. Rust, K. C. Schmidt, and William M. Kerlinger, all of whose services were well rendered.

Money statement.

July 1, 1900, balance unexpended	$505,674.02
June 30, 1901, amount expended during fiscal year	170,135.98
July 1, 1901, balance unexpended	335,538.04
July 1, 1901, outstanding liabilities	445.00
July 1, 1901, balance available	335,093.04
July 1, 1901, amount covered by uncompleted contracts	5,375.90

List of appropriations for improving harbor at Oakland, Cal.

June 24, 1874	$100,000	August 11, 1888	$350,000
March 3, 1875	100,000	September 19, 1890	250,000
August 14, 1876	75,000	July 13, 1892	150,000
June 18, 1878	80,000	August 18, 1894	100,000
March 3, 1879	60,000	June 3, 1896	20,000
June 14, 1880	60,000	June 4, 1897	200,000
March 3, 1881	60,000	July 1, 1898	133,000
August 2, 1882	200,000	March 3, 1899	133,000
July 5, 1884	139,600	June 6, 1900	180,000
August 5, 1886	60,000		
		Total	2,450,600

List of all contracts in force on account of improving harbor at Oakland, Cal.

Contract for—	Name of contractor.	Date of contract.	Date of approval.	Work commenced.	Work completed.	Total cost.
Building drawbridge across the Oakland Harbor tidal canal, at High street, Alameda, Cal.	California Bridge and Construction Co.	Sept. 27, 1899	Oct. 14, 1899	Jan. 15, 1900	Sept. 20, 1900	$24,747
Constructing a diverting channel for Sausal Creek, Oakland Harbor, California.	Clark & Henery	Jan. 18, 1900	Jan. 29, 1900	Mar. 24, 1900	Oct. 4, 1900	53,748
Building drawbridge across the tidal canal at Fruitvale avenue, Oakland Harbor, California.	Darby Laydon	Mar. 6, 1900	Mar. 20, 1900	Mar. 21, 1900	(*a*)	58,759
Repaving Park Street Bridge across tidal canal, Oakland Harbor, California	C. E. Cotton	Aug. 30, 1900	Sept. 10, 1900	Sept. 24, 1900	Oct. 16, 1900	2,357
Dredging in the tidal canal at Oakland, Cal	Atlantic, Gulf and Pacific Co.	June 15, 1901	(*b*)	....	....	(*c*)

[a] Work incomplete. [b] Contract not yet approved. [c] 19.74 cents per cubic yard.

COMMERCIAL STATISTICS.

The following tabulated statements show the traffic by vessels and steamers which passed through the channel way between the jetties during the calendar year 1900.

The classified freight carried by the merchant vessels, embracing staple articles which entered this port of entry during the year, comprised:

	Tons.
Coal, wood, coke, and oil	198,485
Hay, grain, flour, etc	35,648
Lumber	128,160
Building materials	47,440
Sundries	23,397
Total	433,130

It is impossible to classify the miscellaneous freight transported by the several steam ferries, which during the year amounted to 3,111,396 tons, showing an increase of 221,147 tons over the preceding year.

The following table embraces gross statistics of general traffic passing through the jetty channel, both by sail and steam ferries:

Year.	Traffic by ferries.				Traffic by vessels.		
	Number.	Trips.	Passengers.	Freight.	Number.	Register.	Freight.
				Tons.		Tons.	Tons.
1874	1	600	....	60,000	1,415	70,750	94,300
1878	3	5,400	216,240	129,000	1,065	109,125	211,627
1888	3	8,520	200,000	1,876,685	1,384	162,957	295,932
1892	3	8,600	96,000	2,202,170	2,277	223,148	443,011
1893	3	10,250	506,126	2,142,460	1,686	195,090	306,860
1894	4	9,561	554,982	2,119,267	1,741	175,750	309,350
1895	4	9,600	335,868	2,188,906	1,966	200,070	249,788
1896	5	10,500	249,348	2,131,491	1,946	208,155	366,098
1897	5	10,500	248,160	2,283,171	1,352	256,825	340,660
1898	5	10,300	226,068	2,374,546	1,596	288,787	414,849
1899	4	9,600	186,360	2,890,249	1,660	223,764	363,966
1900	4	9,600	164,491	3,111,396	2,025	313,528	489,112

The following comparative grand totals of general traffic through the jetty channel shows conclusively the important growth in water transportation during the past twenty-five years:

General traffic.	1874.		1900.	
	Passengers.	Freight.	Passengers.	Freight.
		Tons.		Tons.
By ferries	None	60,000	164,491	3,111,396
By vessels	None	94,300	....	489,112
Grand total	....	154,300	164,491	3,600,508

Of the above freight, 3,432,764 tons was confined to the portion of the harbor below the bridges and 167,744 tons passed through and above the bridges.

The total customs receips of the port of Oakland during the year 1900 were $10,293.45.

U U 4.

IMPROVEMENT OF SAN JOAQUIN RIVER, CALIFORNIA.

A description of this stream, its original condition, and the plan of improvement are given in the Annual Report of the Chief of Engineers for 1896, page 3189.

REPORT OF OPERATIONS FOR THE FISCAL YEAR ENDING JUNE 30, 1901.

During the year dredging has been carried on in Stockton and Mormon channels. The amount expended was $13,593.42.

At the beginning of the fiscal year dredging was in progress under the contract entered into with A. C. Aiken on October 9, 1899. It was continued until November 29, 1900, when the contract was completed. During the work 32,733 cubic yards of material were dredged from Stockton Channel above Edison street, 128,321 cubic yards from Stockton Channel below Edison street, 6,201 cubic yards from the cut-off at the mouth of Stockton Channel, and 79,967 cubic yards from Mormon Channel, making a total of 245,222 cubic yards of material removed during the progress of the work. The result was a channel 9 feet deep and 100 feet wide to the head of navigation in Stockton Channel, and one 4 feet deep and 80 feet wide to the head of navigation in Mormon Channel. But the winter freshets brought such an enormous amount of detritus from the Calaveras River down Mormon Channel that the excavation made there was entirely refilled and over 100,000 cubic yards of material deposited in Stockton Channel, reducing the depth in the latter to such an extent as to be in the shoalest places only from 1 to 2 feet below low-water plane.

As it was necessary in order to avoid interference with navigation that this shoal should be removed before the river fell, bids were obtained after ten days' public notice, and on May 22, 1901, contract was entered into with the Golden Gate Dredging and Reclamation Company to dredge out the shoal in Stockton Channel for 4.74 cents per cubic yard. Work under this contract was commenced on June 22, 1901, and was still in progress at the end of the fiscal year. The work will probably be completed about the middle of August.

FUTURE OPERATIONS.

The experience of the last year has shown that the amount of detritus brought down and deposited in Mormon and Stockton channels increases every year, as the channels dredged in 1900 and only completed in November, were completely refilled by April, 1901. This is caused by the whole of the water of the Calaveras River, which, when in flood, carries an enormous amount of detritus, coming through Mormon Channel into Stockton Channel and refilling the latter channels as fast as they are dredged.

As the most important work on the San Joaquin River is the maintenance of navigation between Stockton and San Francisco, where commerce is very large and increasing, the channels will, until the water of the Calaveras River is diverted from Mormon Channel, require redredging each year, and as places of deposit adjacent to the channels are rapidly becoming exhausted, this work must soon become very expensive.

Snags which form in the upper river also have to be removed, and the dams at Laird Slough and Paradise Cut require occasional repairs.

All this work is part of the approved project, and it is proposed to expend available funds on such parts of it as require attention.

The emergency river and harbor act of June 6, 1900, directed a preliminary examination of—

San Joaquin River, above the mouth of the Stanislaus River, with a view of determining the advisability of closing the mouths of the more important blind sloughs leading from said San Joaquin River and tributaries, especially those known as Finnegan, Amphlet, and Walden sloughs, that the water in the main channel of the said San Joaquin River may be retained therein and more effectually promote navigation thereof.

This examination was made and report transmitted to Congress. It was printed as House Doc. No. 69, Fifty-sixth Congress, second session. The locality was considered by the local officer as unworthy of improvement by the General Government, and his views were concurred in by the Chief of Engineers.

The same act also directed a preliminary examination of—

The San Joaquin River and the waterways connecting the same with the Straits of Carquines, extending from the town of Antioch to Suisun Point.

A preliminary examination and afterwards a survey were made. The report was transmitted to Congress and printed as House Doc. No 261, Fifty-sixth Congress, second session. The depths of water found in the channels were considered by the local officer as ample for the present needs of commerce.

Money statement.

July 1, 1900, balance unexpended	$44,120.46
June 30, 1901, amount expended during fiscal year	13,593.42
July 1, 1901, balance unexpended	30,527.04
July 1, 1901, outstanding liabilities	200.00
July 1, 1901, balance available	30,327.04
July 1, 1901, amount covered by uncompleted contracts	5,024.00
Amount (estimated) required for completion of existing project	Indeterminate.
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	25,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

List of all appropriations for improving San Joaquin River, California.

August 14, 1876	$20,000	September 19, 1890	$75,000
June 14, 1880	20,000	July 13, 1892	65,000
March 3, 1881	40,000	August 18, 1894	50,000
August 2, 1882	40,000	June 3, 1896	57,750
July 5, 1884	20,000	March 3, 1899	20,000
August 5, 1886	18,750		
August 11, 1888	75,000	Total	451,500

LIST OF ALL CONTRACTS IN FORCE ON ACCOUNT OF IMPROVING SAN JOAQUIN RIVER, CALIFORNIA.

Contract dated October 9, 1899, for dredging in Stockton and Mormon channels, California.

[At the following prices: Stockton Channel above Edison street, 11 cents per cubic yard; Stockton Channel below Edison street, 10 cents per cubic yard; cut-off at mouth of Stockton Channel, 29 cents per cubic yard, and Mormon channel, 9 cents per cubic yard.]

Name of contractor.	Date of approval.	Work commenced.	Work completed.
A. C. Aiken	Oct. 25, 1899	Feb. 8, 1900	Nov. 29, 1900.

Contract dated May 22, 1901, for dredging in Stockton Channel, San Joaquin River, California.

[At 4.74 cents per cubic yard.]

Name of contractor.	Date of approval.	Work commenced.	Work completed.
Golden Gate Dredging and Reclamation Co	June 6, 1901	June 22, 1901	Work still in progress.

COMMERCIAL STATISTICS.

The following is a statement of the business done by the California Navigation and Improvement Company on the San Joaquin River, California, during the calendar year 1900:

Lower San Joaquin River:

Merchandise	tons	80,243
Mill stuffs	do	66,035
Coal	do	2,185
Grain	do	33,303
Lumber	do	14,121
Total	do	195,887
Passengers		55,637

The following is a statement, in round numbers, of the business done by the Union Transportation Company on the San Joaquin River during the calendar year 1900:

Lower San Joaquin River:

General freight	tons	75,000
Passengers		53,000

Owing to the failure of the crop in the Upper San Joaquin Valley, no business was done on the Upper San Joaquin River (above Stockton) during the year 1900.

Several scow schooners also do a considerable business on this river, but it is impossible to obtain a statement of the amount.

The total freight of the San Joaquin River for the year 1900 was reported as 248,887 tons.

Comparative yearly statement of freight of the San Joaquin River.

Year.	Passengers.	Freight.	Year.	Passengers.	Freight.
		Tons.			*Tons.*
1880		230,824	1896	97,880	431,736
1892	90,000	395,000	1897	112,089	454,955
1893	154,509	346,094	1898	64,975	287,524
1894	100,178	295,651	1899	188,882	270,018
1895	61,581	401,684	1900	108,637	248,887

U U 5.

IMPROVEMENT OF MOKELUMNE RIVER, CALIFORNIA.

A description of this stream, project for its improvement, work done, and commerce interested is given in the Annual Report of the Chief of Engineers for 1899, page 3168.

No work has been done and no funds have been expended during the fiscal year. It is not thought that any work will be required in the immediate future, as there is a least depth of 3 feet at mean low water to Newhope Landing, the head of navigation, which is believed to be sufficient to handle the commerce of the stream.

FUTURE OPERATIONS.

There is at present available the sum of $888.34, which it is believed will be sufficient to remove any snags or overhanging trees which in the near future may obstruct navigation.

Money statement.

July 1, 1900, balance unexpended	$888.34
July 1, 1901, balance unexpended	888.34
Amount (estimated) required for completion of existing project	Indeterminate.

Amount and date of appropriations for improving Mokelumne River, California.

July 5, 1884	$8,500
August 5, 1886	2,500
August 11, 1888	2,000
July 13, 1892	2,500
August 18, 1894	2,500
Total	18,000

COMMERCIAL STATISTICS.

The following is a statement of the business done on the Mokelumne River during the year 1900 by the steamer *Constance*, belonging to the California Transportation Company, which runs between San Francisco and Newhope Landing.

Coal	tons	2,000
Merchandise, produce, and grain	do	84,989
Total	do	86,989
Passengers		16,313

A large amount of freight is also carried on the various scow schooners which run on the river, but it is impossible to obtain any statement of their business.

U U 6.

IMPROVEMENT OF SACRAMENTO AND FEATHER RIVERS, CALIFORNIA.

GENERAL IMPROVEMENT.

A description of these streams, their original condition, and the plans for their improvement are found in the Annual Report of the Chief of Engineers for 1896, page 3195.

REPORT OF OPERATIONS FOR THE FISCAL YEAR ENDING JUNE 30, 1901.

The work done during the year consisted of wing-dam building and snag removal by the U. S. snag boat *Seizer*. The amount expended was $13,505.26.

The snag boat was put in commission on July 10, 1900, and immediately started for the upper river, removing on the way snags which offered the greatest obstruction to navigation. Redbluff was reached on September 20, when the boat was again turned downstream, removing all snags as she went, arriving at Sacramento on October 8. After coaling the boat was taken to the lower river where she was kept at work removing snags and cutting overhanging trees from the banks until November 3, when she was laid up for that winter at Sacramento.

During the work 860 snags were removed and 537 overhanging trees cut from the banks. There were 489 blasts fired, using 2,119 pounds of No. 1 dynamite. The boat ran 940 miles.

The crew of the boat also built a wing dam at Sam Soule bar 210 feet long, which contained 82 piles and 249 cubic yards of brush.

The snag boat was in commission 117 days and cost $12,530.72, or $107.94 per day.

FUTURE OPERATIONS.

The navigation of the Upper Sacramento River requires that the snags which have formed during the floods of the past winter should be removed; but, as there are no funds available to run the snag boat, this can not be done at present.

The work of building wing dams and removing snags is necessary in the upper Sacramento River every year to keep navigation open during the low stages of the river, at an estimated annual cost of about $25,000.

REMARKS.

As the general improvement of this river is under the charge of a Board of three Engineer officers, organized by virtue of the act of Congress passed June 3, 1896, which has made a project and submitted estimates for their improvement, no estimate is made in this report other than for continuing the work of the United States snag boat.

Money statement.

July 1, 1900, balance unexpended	$14,138.79
June 30, 1901, amount expended during fiscal year	13,505.26
July 1, 1901, balance unexpended	633.53
July 1, 1901, outstanding liabilities	75.00
July 1, 1901, balance available	558.53

Amount (estimated) required for completion of existing project	Indeterminate.
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	25,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

SACRAMENTO RIVER (FROM THE CITY OF SACRAMENTO TO THE MOUTH), CALIFORNIA.

The river and harbor act of March 3, 1899, contained the following clause:

> Improving Sacramento River, California, from the city of Sacramento to the mouth: Continuing improvement, thirty thousand dollars: *Provided*, That a contract or contracts may be entered into by the Secretary of War for such materials and work as may be necessary to carry out the revised project printed in House Docu-

ment Numbered one hundred and eighty-six, Fifty-fifth Congress, second session, and House Document Numbered Forty-eight, Fifty-fifth Congress, third session, to be paid for as appropriations may from time to time be made by law, not to exceed in the aggregate the sum of two hundred and fifty thousand dollars, exclusive of amount herein and heretofore appropriated.

In accordance with this appropriation project was made and approved for a series of wing dams opposite the city of Sacramento, extending as far out into the stream and of such number as might be found necessary to deepen the shoal water which extended along and below the city front.

REPORT OF OPERATIONS FOR THE FISCAL YEAR ENDING JUNE 30, 1901.

Work under the contract entered into with the City Street Improvement Company, of San Francisco, Cal., on September 1, 1899, for building the wing dams opposite the city of Sacramento, had not been completed at the beginning of the fiscal year, but was suspended owing to the high stage of the river. Up to that time three wing dams had been completed and a fourth commenced. Work was resumed on August 6, 1900, and completed on November 1, 1900. During the work a series of 11 wing dams, aggregating 1,890 feet in length, was constructed opposite the city of Sacramento, so as to remove a shoal which had formed and impeded navigation. An additional 35 feet was also added to a wing dam which had been previously built. The dams contained 432 piles, 3,336.76 cubic yards of brush, and 888.61 tons of rock, and cost $6,962.62.

The river rose shortly after the wing dams were completed, and as it has not yet reached its low-water stage the result of the work can not yet be determined.

Congress having in the sundry civil act of June 6, 1900, appropriated an additional $60,000 for this work, plans were made for additional wing dams at such places as they might be necessary between the city of Sacramento and the mouth of the river, and proposals for building them were invited. Bids were opened on February 18, 1901, and on March 20, 1901, a contract was made with Darby Laydon, of San Francisco, Cal., to do the work. Operations have not yet been commenced as the river is at too high a stage. It will probably fall sufficiently to permit of work being commenced about August 1.

During the fiscal year the sum of $5,799.39 has been expended, making the total expenditure on this work to June 30, 1901, $8,142.75.

As the improvement is under the direction of a Board of Engineer officers constituted by Special Orders, No. 18, headquarters Corps of Engineers, July 27, 1896, as authorized by the river and harbor act of June 3, 1896, no estimate for future work is made. The annual report of this Board is herewith.

Money statement.

July 1, 1900, balance unexpended	$87,656.64
June 30, 1901, amount expended during fiscal year	5,798.39
July 1, 1901, balance unexpended	81,858.25
July 1, 1901, amount covered by uncompleted contracts	25,306.00

REPORT OF THE BOARD OF ENGINEERS ON IMPROVEMENT OF SACRAMENTO AND FEATHER RIVERS, CALIFORNIA.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., July 2, 1901.

GENERAL: The Board of Engineers organized by virtue of the river and harbor act of Congress passed June 3, 1896, now consists of Col. Jared A. Smith, Lieut. Col. W. H. Heuer, and Lieut. Col. Charles E. L. B. Davis, all of the Corps of Engineers, U. S. A., and has charge of the improvement of the Sacramento and Feather rivers, California.

During the past fiscal year Col. S. M. Mansfield, United States Engineers, in consequence of being ordered East, was relieved from duty with this Board, and Col. Jared A. Smith succeeded him as senior member of the Board.

The Board has held five business meetings in the past year, has prepared projects for additional wing dams in the river opposite and below the city of Sacramento, has reported on a project submitted by the Western Dredging Company for permission to build a relief canal from the Sacramento to the Feather River, and has considered bids and made recommendations on same for wing dams on the Lower Sacramento River between Sacramento and the mouth of the river.

The plan of improvement, with estimate of cost for improving Sacramento River, was submitted by the Board and printed in House Document No. 48, Fifty-fifth Congress, third session. The general plan contemplated the construction of wing dams at various shoal places in the river below Sacramento, to be supplemented by dredging, if required, at an estimated cost of $280,000, and the maintenance of navigation on the upper river between Sacramento and Redbluff by concentration of channel widths by temporary work and the removal of snags, at an estimated annual expense of $25,000. The project contemplates a low-water channel depth of 7 feet to Sacramento, 4 feet to Colusa, and 3 feet to Redbluff, Cal.

The river and harbor act of March 3, 1899, appropriated $30,000 and authorized continuing contracts up to a limit of $280,000 for the completion of the improvement of the river below Sacramento, and on June 6, 1900, in the sundry civil act, Congress appropriated $60,000 for continuing improvement from Sacramento to the mouth of the river.

The contract made in September, 1899, for building as many dams as might be required to remove the large shoal in front of the city of Sacramento, was completed on October 31, 1900. During the time of existence of this contract 11 wing dams were built and 1 old one repaired.

These wing dams are unequally distributed on the right bank of the river for 5,700 feet of its length, are placed an average distance apart of 477 feet, and average in length about 158 feet. The cost, exclusive of engineering expenses, was $6,962.62, or at an average rate of $3.14 per linear foot of wing dam built.

The following table furnishes details of each wing dam:

Name.	Length of dam.	Number of bents.	Number of piles.	Feet of piling.	Brush.	Rock.	Remarks.
	Feet.				*Cu. yds.*	*Tons.*	
A	168.3	18	39	1,126	260.86	84.02	
B	170	17	38	1,215	338.59	89.84	
C	170	17	37	1,253	422.01	112.30	
D	145	15	33	1,104	397.76	75	
E	150	16	35	1,184	289.81	84	
F	159	17	37	1,126	229.86	77.53	
G	180	19	41	1,166	255.85	83.75	
H	35	4	8	250	72.06	21.75	Repaired.
I	221.8	23	49	1,260	256.17	89.71	
J	180	19	41	1,161	286.91	81.18	
K	170	18	39	1,179	294.01	104.95	
L	149.3	16	35	1,036	233.87	77.63	
Total	1,898.4	199	432	13,060	3,336.76	981.66	

It is known that immediately after the completion of these dams a beneficial effect in depth over the shoal was obtained. As there has been no low-water period since their completion, the exact or even an approximate increase in depth has not been determined, but it is believed that a least depth of 7 feet at low water has been obtained.

As the low-water season, during which period effective wing-dam construction can be done, generally lasts only from August to October or November following, as it is impossible to predetermine the location of material that may be scoured out in consequence of channel contraction works, and as it would be necessary to build wing dams only at such shoals as might from time to time be developed which would be likely to interfere with navigation, it was deemed injudicious to make any continuing contract for the completion of the work. Contracts were therefore made for only such work as was urgent, and always within the limit of funds actually on hand.

The method thus far pursued has been economical and advantageous to the Government in the removal of the shoal in front of the city of Sacramento, which has been accomplished with about one-third of the number of wing dams, and consequently at a cost of about one-third of that estimated for by the Board.

On February 18, 1901, bids were opened for building as many wing dams, based on unit prices of material, as might be necessary for the treatment of any shoals between Sacramento and the mouth of the river. Contract was awarded to Darby Laydon, the lowest bidder, on a basis of 13.5 cents per linear foot of pile, $1.97 for driving each pile, 89 cents per cubic yard for brush in place, $1.93⅞ per ton of rock in place, and $22.50 per thousand feet of Oregon pine lumber, and the estimated cost of the work under this contract is $25,306. The contract is quite elastic as regards quantities, number and location of dams that may be required, and is fixed and determinate only as to unit prices of material.

It is believed and hoped that the money now appropriated and available will complete the entire project contemplated in the Board's report of October 11, 1898, at a total cost of less than one-third of its original estimated cost. It will be observed that no appropriation has yet been made since the project of 1898 was submitted for the treatment and maintenance of the upper river above Sacramento. The language of the acts appropriating the $90,000 now available limits its expenditure between Sacramento and the mouth of the river, and has been interpreted in such a way that it does not even admit of removing any snags which are now or may be hereafter lodged in the lower river. This is unfortunate and ought to be remedied. Former appropriations were generally applicable to any portion of the navigable part of the Sacramento or Feather rivers which required treatment. These former appropriations have been practically exhausted, and in consequence thereof, and the failure of Congress at its last session to make any appropriation for rivers and harbors, the State of California has been compelled, at its own expense, to advertise for bids for removal of snags to maintain navigation, and the price bid is nearly double what it costs the Government per snag for the same class and amount of work.

It is believed that the removal of snags and the construction of temporary wing dams are of the utmost importance on the whole river for the improvement and maintenance of navigation. The average annual cost during the past ten years of this class of work (exclusive of extraordinary repairs to the snag boat) has been about $20,000, and it has been confined almost entirely to that part of the river above Sacramento.

An annual appropriation of $25,000, it is estimated, could be advantageously used for snagging and maintaining good navigation on the entire river between its mouth and the head of navigation at Redbluff. During the past year there has been practically no interruption to navigation.

As the funds on hand are believed to be sufficient to complete the work provided for by contract on the lower river to June 30, 1903, no further estimate for this work is submitted, but money for snagging and maintaining navigation is nearly exhausted, and $25,000 is urgent and necessary to be applied to such work on the whole river.

Respectfully submitted.

JARED A. SMITH,
Colonel, Corps of Engineers.
W. H. HEUER,
Lieut. Col., Corps of Engineers.
CHAS. E. L. B. DAVIS,
Lieut. Col., Corps of Engineers.

Brig. Gen. G. L. GILLESPIE,
Chief of Engineers, U. S. A.

List of all appropriations for improving Sacramento and Feather rivers, California.

March 3, 1875	$15,000	August 11, 1888	$20,000
June 18, 1878	15,000	September 19, 1890	30,000
March 3, 1879	20,000	July 13, 1892	150,000
June 14, 1880	45,000	August 18, 1894	115,000
March 3, 1881	60,000		
August 2, 1882	250,000	Total	790,000
July 5, 1884	40,000		

List and date of all appropriations for improving Sacramento River, California.

March 3, 1899	$30,000
June 6, 1900	60,000
Total	90,000

ABSTRACT OF ALL CONTRACTS IN FORCE FOR IMPROVING SACRAMENTO RIVER, CALIFORNIA.

Contract dated September 1, 1899, for building wing dams in the Sacramento River, opposite the city of Sacramento, Cal.

[At the following prices: Piles, at 14.7 cents per linear foot; driving piles, at $1.54 per pile; brush, at 65 cents per cubic yard, and stone, at $2.25 per ton.]

Name of contractor.	Date of approval.	Work commenced.	Work completed.
City Street Improvement Company	Sept. 22, 1899	Oct. 2, 1899	Nov. 1, 1900

Contract dated March 20, 1901, for building wing dams in the Sacramento River, California.

[At the following prices: Piles, at 18¾ cents per linear foot; driving piles, at $1.97 per pile; brush, at 89 cents per cubic yard; stone, at $1.98¾ per ton, and lumber in the temporary wharf, if required, at $22.50 per thousand feet.]

Name of contractor.	Date of approval.	Work commenced.	Work completed.
Darby Laydon	Apr. 5, 1901	Work not commenced.	

COMMERCIAL STATISTICS.

Statistics of trade of the Sacramento River, California, for the calendar year 1900.

The following is the freight carried by the boats of the Southern Pacific Company:

Between San Francisco and Sacramento, including all way freight ...tons.. 160,765

The following freight was carried by the boats of the California Transportation Company, including all way freight, between San Francisco and Clarksburg, a distance of 110 miles:

Coal	tons..	3,167
Produce and merchandise, grain and lumber	do...	86,814
Total		89,981
Passengers		12,340

The following is a statement of the freight carried by the Sacremento Transportation Company between San Francisco and Red Bluff, the head of navigation on the Sacramento River:

Lower river, below Sacramento.

	Tons.
From San Francisco to Sacramento:	
General merchandise	19,250
Coal	12,985
Lumber	20,000
From Sacramento to San Francisco:	
General merchandise	3,300
Brick	25,507
Flour	1,550
Miscellaneous	2,000
From Riverside to Sacramento:	
Brick	7,822

The total tonnage of the freight carried on the Lower Sacramento River (from the city of Sacramento to the mouth) during the year 1900, as furnished by the various transportation companies, was 439,489 tons.

Upper river, above Sacramento.

	Tons.
From San Francisco and Sacramento to up-river points:	
Lumber	6,000
General merchandise to points below Redbluff	5,200
General merchandise to Redbluff	4,150
From up-river points to San Francisco:	
Hay	1,200
Broom corn	700
Wool	450
Dried fruit	320
Miscellaneous	1,230
From up-river points to Sacramento:	
Wood	6,000
Corn	1,300
Potatoes	2,000
Wheat and barley	3,000
Hogs and cattle	375
Miscellaneous	900

Grain shipments from up-river points to San Francisco, Port Costa, and Vallejo.

	Tons.
From Knights Landing to and including Colusa	51,598
From above Colusa to and including Butte City	29,951
From above Butte City to and including Jacinto	6,965
From above Jacinto to and including Chico Landing	7,998
From above Chico Landing to and including Tehama	6,299
From above Tehama	1,540
Total tonnage of the Sacramento Transportation Company's boats	210,568
Total tonnage of the Sacramento River for 1900	461,314

The commerce of the Sacramento River is carried on 8 steamers, 16 grain barges, and 7 brick barges belonging to the Sacramento Transportation Company; 5 steamers and 7 barges belonging to the California Transportation Company, and 2 steamers belonging to the Southern Pacific Company. The steamers vary in size from 183 to 619 tons, and the barges from 118 to 800 tons. The larger steamers do not go above Sacramento, the commerce of the upper river being carried on barges towed by light-draft steamers.

Statistics of commerce of the Feather River, California, for the calendar year 1900.

On the Feather River, during the high-water season, a small steamer belonging to the Southern Pacific Company makes one round trip each week with a barge and takes all the freight that offers. The following is a statement of the freight carried during the calendar year 1900:

	Tons.
Freight, north and south	4,411

Comparative yearly statement of freight transported on the Sacramento River, California.

Year.	Freight.	Year.	Freight.
	Tons.		*Tons.*
1878	167,000	1894	358,014
1879	200,925	1895	419,647
1880	201,000	1896	363,658
1890	249,105	1897	422,111
1891	353,056	1898	394,675
1892	579,574	1899	484,806
1893	466,343	1900	461,314

U U 7.

IMPROVEMENT OF NAPA RIVER, CALIFORNIA.

A description of this stream, its original condition, the plan for its improvement, and the results obtained are given in the Annual Report of the Chief of Engineers for 1896, page 3177.

REPORT OF OPERATIONS FOR THE FISCAL YEAR ENDING JUNE 30, 1901.

Work under the contract to redredge Napa River, entered into with Willis G. Witter and Marshall C. Harris at the end of last fiscal year, was commenced on July 21, 1900. Work was done at Jacks Bend, Steamboat Point, and Woolen Mills, and the contract completed on August 15, 1900, when the width and depth required by the approved project had been obtained. The amount of material removed and placed on shore was 27,648 cubic yards. The price paid the contractors was 12.45 cents per cubic yard.

The sum of $3,621.42 was expended during the fiscal year.

FUTURE OPERATIONS.

The depths obtained by the dredging will not be permanent, as the detritus brought down by the winter floods will continually form new bars. As the tides rise from 5 to 7 feet, a comparatively small amount of work is necessary to keep navigation in good condition for the class of boats which ply on the river.

Money statement.

July 1, 1900, balance unexpended	$4,044.91
June 30, 1901, amount expended during fiscal year	3,621.42
July 1, 1901, balance unexpended	423.49
Amount (estimated) required for completion of existing project	Indeterminate.
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	4,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897.	

List of all appropriations for improving Napa River, California.

August 12, 1888	$7,500
September 19, 1890	10,000
August 18, 1894	4,000
June 3, 1896	4,000
Total	25,000

ABSTRACT OF ALL CONTRACTS IN FORCE FOR IMPROVING NAPA RIVER, CALIFORNIA.

Contract dated June 30, 1900, for redredging Napa River, California.

[For 12.45 cents per cubic yard.]

Name of contractor.	Date of approval.	Work commenced.	Work completed.
Willis G. Witter and Marshall C. Harris	July 21, 1900	July 24, 1900	Aug. 15, 1900

COMMERCIAL STATISTICS.

The following is a statement of the freight carried on Napa River, with the increase since 1884:

Articles.	1884.	1898.	1899.	1900.
Merchandise received and shipped	22,800	27,980	49,500	24,960
Coal received	5,000	14,900	25,500	11,550
Hay shipped	2,000	12,750	8,775	6,000
Grain received and shipped	8,000	15,750	44,900	17,000
Wine received and shipped	7,500	14,750	11,075	7,400
Lumber received	18,333	2,250	12,802	9,166
Miscellaneous received and shipped	5,936	5,945	8,443	5,460
Total	64,569	95,825	160,495	81,536
Steamers	2	2	2	2
Tonnage	176	527	527	575
Trips by steamer	Daily.	Daily.	Daily.	Daily.
Trips by schooners	Daily.	Daily.	Daily.	Daily.

U U 8.

IMPROVEMENT OF PETALUMA CREEK, CALIFORNIA.

A description of this creek, its condition before improvement, project for improvement, and work done will be found in the Annual Report of the Chief of Engineers for 1896, page 3205.

REPORT OF OPERATIONS FOR THE FISCAL YEAR ENDING JUNE 30, 1900.

During the fiscal year no work has been done and no funds expended. The depths secured by the last dredging have been generally maintained and traffic has been uninterrupted.

FUTURE OPERATIONS.

The channel in this stream is not self-maintaining, as the detritus brought down from the highly cultivated region through which the stream flows causes constant shoaling. This renders redredging, at an estimated cost of $4,000, necessary about every two years.

Money statement.

July 1, 1900, balance unexpended	$313.03
July 1, 1901, balance unexpended	313.03
Amount (estimated) required for completion of existing project	Indeterminate
Amount that can be profitably expended in fiscal year ending June 30, 1903, in addition to the balance unexpended July 1, 1901	$4,000.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897.

List of all appropriations for improving Petaluma Creek, California.

June 14, 1880	$8,000	July 13, 1892	$10,000
March 3, 1881	8,000	August 18, 1894	15,000
August 2, 1882	14,000	March 3, 1899	4,000
August 11, 1888	2,000		
September 19, 1890	4,000	Total	65,000

COMMERCIAL STATISTICS.

The following is a statement of the business of the steamer *Gold*, 294 tons, the only steamer running on the creek during the year 1900:

Articles.	Tons.	Articles.	Tons.
Lumber and shingles	1,243	Fruits, green and dried	1,314
Hay	80	Butter and eggs	1,633
Merchandise	11,065	Miscellaneous	268
Coal	580		
Wool	46	Total	18,893
Produce	1,009	Passengers	12,104
Live stock	1,655		

A very large quantity of the heavier freight is carried on scow schooners, many of which make regular trips to the different landings just below Petaluma, but no reliable statement of their business can be obtained.

Upon the visit of a committee from Congress to Petaluma, on June 21, 1901, a copy of the following was furnished to each member:

STATISTICS ON PETALUMA RIVER.

To the honorable the board of trustees of the city of Petaluma.

Gentlemen: Pursuant to instructions, I hereby submit the statistics of trade, via river, for the year ending June 15, 1901. They are taken from figures furnished by the leading local dealers and shippers, and are very conservative in every respect. These figures do not include shipments to and from Lakeville, the Fair Ranch, or the several warehouses or landings along the river, but from the city of Petaluma only. Neither do they include the business done by the many trading boats which constantly ply on the stream.

	Tons.		Tons.
Wheat	14,000	Hay	60,000
Barley	4,500	Corn	3,000
Flour	12,000	Potatoes	6,500
Bran, shorts, middlings	12,000	Oats	4,500
Sugar beets	550	Onions	100
Fish	200	Coal	3,500
Oil, cake meal, cocoanut cake	1,600	Butter	600
Lumber	18,000	Shingles	1,500
Pickets	350	Shakes	600
Windows, casings, moldings	100	Wire	50
Salt	2,000	Lime	500
Shells for chickens	1,500	Granite and marble	50
Vehicles	1,600	Paving blocks	5,000
General merchandise	9,000	Laths	700
Raw silk	100	Doors	30
Bricks	600	Cement	700
Plaster	150	Iron and steel	350
Iron pipe	120	Machinery	175
Wine	200	Hops	50
Wool	400	Tallow	20
Cheese	40	Leather	100
Pelts	60	Hides	245
Green fruits	2,000	Dried fruits	1,000
Ice	100	Mowers	100
Tin, sheet iron, cans, etc	60	Saddletrees	10
Incubators, brooders, etc	150	Boots and shoes	15
Furniture	50	Melons	50
Castings, etc	15	Hay presses	100
Oil, gasoline, etc	100	Sundries	200
Crushed rock	800		

Sheep and hogs	head	8,000
Horses and cattle	do	5,000
Eggs	dozen	1,500,000
Poultry	do	7,000
Passengers		20,000

Respectfully submitted.

ART S. NEWBURGH, *City Clerk.*

U U 9.

IMPROVEMENT OF HUMBOLDT HARBOR AND BAY, CALIFORNIA.

A description of this bay, its original condition, and the plans for its improvement are given in the Annual Report of the Chief of Engineers for 1896, page 3207.

REPORT OF OPERATIONS FOR THE FISCAL YEAR ENDING JUNE 30, 1901.

The amount expended on this work during the fiscal year was $1,369.06.

The approved projects for the improvement of Humboldt Harbor have all been completed. A full and detailed description of the work was printed in the Annual Report of the Chief of Engineers for 1900, pages 4237-4245.

During the fiscal year the property on the site has been in charge of a custodian, who has made such minor repairs to the buildings as were necessary to keep them in order. In January, 1901, the sea encroached on two of the buildings to such an extent as to render them unsafe, and they were removed to a more secure location.

As far as can be ascertained from the pilots navigating this harbor, the channel widths and depths secured by the work of improvement have practically been maintained.

Money statement.

July 1, 1900, balance unexpended	$15,772.46
June 30, 1901, amount expended during fiscal year	1,369.06
July 1, 1901, balance unexpended	14,403.40
July 1, 1901, outstanding liabilities	75.00
July 1, 1901, balance available	14,328.40

Amount and date of all appropriations for improving Humboldt Harbor and Bay, California.

March 3, 1881	$40,000	March 2, 1895	$225,000
August 2, 1882	40,000	June 11, 1896	225,000
July 5, 1884	62,500	June 4, 1897	350,000
August 5, 1886	75,000	July 1, 1898	100,000
August 11, 1888	125,000	March 3, 1899	50,000
September 19, 1890	80,000	March 3, 1899	143,115
July 13, 1892	150,000		
March 3, 1893	522,000	Total	2,187,615

COMMERCIAL STATISTICS.

The following statement of the export trade of Humboldt Bay, California, for the year 1900 was collected and supplied by Mr. George A. Kellogg, secretary of the Humboldt Chamber of Commerce:

Exports.

Articles.	Weight.	Value.
	Tons.	
Lumber	242,045	$2,242,520
Produce	10,962	1,669,295
Miscellaneous	4,261	75,390
Total	257,268	3,987,205

In the foregoing lumber exports are included the following colonial and foreign shipments:

Country.	Number of cargoes.	Weight.	Value.
		Tons.	
Hawaiian Islands	34	16,874	$158,441
Australia	14	13,845	147,891
Mexico	2	947	9,040
China	1	632	6,862
Central America	1	358	2,786
Total	52	32,656	319,520

The following statement of the imports into Humboldt Bay during the year 1900 was carefully estimated by the harbor commissioners and published by them:

Imports.

Articles.	Tons.	Value.
General merchandise	40,607	$1,825,315
Miscellaneous	2,212	69,969
Total	42,819	1,895,284

Movement of vessels, tonnage, and passengers.

	Steam vessels.	Sail vessels.	Total vessels.	Tonnage.	Passengers.
Arrived	414	169	583	238,419	8,368
Departed	419	167	586	239,769	7,988
Total	833	336	1,169	478,188	16,356

The following is a statement of the freight carried by the Pacific Coast Steamship Company between San Francisco and Humboldt Bay during the year 1900:

	Tons.
San Francisco to Humboldt Harbor	20,540
Humboldt Harbor to San Francisco	35,978
Total	56,518

The following is a statement of the business done by the steamer *North Fork*, running between San Francisco and Humboldt Bay, during the year 1900:

	Received at Humboldt Bay.	Delivered at Humboldt Bay.
Lumber .... Tons..	84,558	....
Merchandise .... do....	800	8,151
Passengers .... Number..	527	598

Comparative yearly statement of freight of Humboldt Bay, California.

	Passengers.	Freight.		Passengers.	Freight.
	Number.	*Tons.*		*Number.*	*Tons.*
1885	4,195	162,614	1895	11,514	226,378
1886	4,584	193,607	1896	18,252	168,825
1891	12,696	522,898	1897	14,742	216,611
1892	14,664	286,719	1898	12,246	210,639
1893	15,201	217,541	1899	18,858	806,520
1894	11,261	185,594	1900	16,856	300,087

U U 10.

IMPROVEMENT OF PEARL HARBOR, HAWAII.

Pearl Harbor is situated on the island of Oahu, about 8 miles west of the city of Honolulu. It is a safe and commodious harbor, with deep water, but the entrance is obstructed by a bar about 1,900 feet through, having at low water only about 10 feet of water over it at its shoalest place.

A full description of the harbor was printed as Senate Ex. Doc. No. 42, Fifty-third Congress, third session.

The river and harbor act of March 3, 1899, provided as follows:

> Improving Pearl Harbor, Hawaii, in accordance with the report submitted by Rear-Admiral Walker, July eleventh, eighteen hundred and ninety-four, and contained in Senate Executive Document Numbered Forty-two, Fifty-third Congress, third session: Completing improvement, one hundred thousand dollars.

A project for the expenditure of the funds appropriated, in accordance with the terms of the act, was made in October, 1900, which provided for bids being invited for dredging a channel through the bar to a depth of 30 feet at low water and as wide as the funds available would permit. This project was approved on December 5, 1900, and proposals advertised for. Bids were opened on February 27, 1901, but were all rejected. The work was again advertised, and bids opened on June 24, 1901. The lowest bid received was that of Clark and Henry, of Stockton, Cal., at 44½ cents per cubic yard. The bids were forwarded to the Department for consideration, but up to the end of the fiscal year no contract had been made.

The sum of $230.49 was expended during the last fiscal year.

Money statement.

July 1, 1900, balance unexpended	$100,000.00
June 30, 1901, amount expended during fiscal year	230.49
July 1, 1901, balance unexpended	99,769.51

APPROPRIATION.

March 3, 1899	$100,000

U U 11.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

REMOVAL OF WRECK OF MAY FLINT.

On September 8, 1900, the iron ship *May Flint*, 3,576 tons register, laden with coal, collided with the U. S. battle ship *Iowa* and immediately thereafter sank in San Francisco Bay, California, in about 60 feet of water, where she was a menace and serious danger to navigation.

The matter was reported to the Secretary of War and on October 10, 1900, an arrangement was made with the owner of the wreck by which he was to remove the same to a depth of 35 feet below low water free of expense to the United States. A bond for $20,000 was given for the proper fulfillment of the agreement.

Most of the coal in the wreck has been removed by the owner and the vessel itself partly broken up and removed. It is expected that the work will be completed in September next without any expense to the United States other than the sum of $1.34 paid for two telegrams which passed between San Francisco and the Department in Washington.

U U 12.

EXAMINATION AND SURVEY OF OAKLAND HARBOR, CALIFORNIA.

[Printed in House Doc. No. 262, Fifty-sixth Congress, second session.]

Office of the Chief of Engineers,
United States Army,
Washington, December 27, 1900.

Sir: I have the honor to submit herewith copies of reports dated July 26 and December 19, 1900, by Lieut. Col. W. H. Heuer, Corps of Engineers, upon preliminary examination and survey, respectively, of Oakland Harbor, California, authorized by the emergency river and harbor act approved June 6, 1900, as follows:

> Oakland Harbor: With a view to the improvement of said harbor to meet the needs of present and prospective commerce from the western end of the tidal canal to deep water in San Francisco Bay, including the excavation of a tidal basin.

Oakland Harbor has been under improvement by the General Government since 1874, and in the opinion of the local officer the locality is worthy of further improvement on account of the great increase in commerce since that date. At present the entrance to the harbor is 300 feet wide and 20 feet deep at low water. Alternate estimates for continuing the improvement of the harbor to different depths and widths have been prepared by Colonel Heuer, as follows:

For a channel 500 feet wide and 20 feet deep at low water, from San Francisco Bay to Fallon street, Oakland; thence 300 feet wide and 17 feet deep to the tidal basin; thence 300 feet wide and 12 feet deep around the tidal basin	$646,293
For a channel 500 feet wide and 25 feet deep, from San Francisco Bay to Fallon street, Oakland; thence 300 feet wide and 25 feet deep up to and around the tidal basin	1,687,818
For a channel 500 feet wide and 25 feet deep, from San Francisco Bay to Chestnut street, Oakland; thence 300 feet wide and 25 feet deep to Fallon street; thence 300 feet wide and 17 feet deep to the tidal basin; thence 300 feet wide and 12 feet deep around the tidal basin	968,203

Each of these estimates includes an item of $53,900 for the extension of the south jetty 550 feet westward.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

HON. ELIHU ROOT,
Secretary of War.

PRELIMINARY EXAMINATION OF OAKLAND HARBOR, CALIFORNIA, WITH A VIEW TO ITS IMPROVEMENT FROM THE WESTERN END OF THE TIDAL CANAL TO DEEP WATER IN SAN FRANCISCO BAY, INCLUDING THE EXCAVATION OF TIDAL BASIN.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., July 26, 1900.

GENERAL: In compliance with your instructions and in accordance with the emergency river and harbor act of June 6, 1900, the following report of a preliminary examination of "Oakland Harbor [California], with a view to the improvement of said harbor to meet the needs of present and prospective commerce from the western end of the tidal canal to deep water in San Francisco Bay, including the excavation of a tidal basin," is respectfully submitted.

A brief history of Oakland Harbor, with a general description of its present condition, by Mr. L. J. Le Conte, assistant engineer, who has been in local charge of the improvement since its beginning, is appended.

The harbor, so far as completed, is really a development and enlargement of San Antonio Estuary, which was in a marsh about 3 square miles in area, situated between the cities of Oakland and Alameda, in which the tide ebbed and flowed in sufficient volume to maintain a channel at its throat in San Francisco Bay having a least depth of about 2 feet at low water, and which in various narrow places throughout its length had depths as great as 20 to 23 feet.

In 1874, in compliance with an act of Congress, a Board of United States Engineer Officers submitted a report with plan and estimate for a harbor at this locality estimated to cost, in round numbers, $1,815,000. This Board recommended the construction of two half-tide jetties, about 1,000 feet apart, at the entrance to the estuary, to extend to deep water of San Francisco Bay; then to dredge a channel 100 feet wide and 6 feet deep at low water between the jetties, to break the hard-surface crust at the entrance, with the hope that the increased tidal flow would then widen and deepen the channel to 14 feet or more at low water; then to excavate a tidal canal from the upper end of the estuary to San Leandro Bay, close the outlet of the latter by a dam and tide gate, so as to divert the ebb tide from this bay through the tidal canal and estuary, with a view to scour out a channel which was to constitute the harbor proper to a depth of 20 to 22 feet; then to excavate a tidal basin to a depth of 2 feet in the upper harbor, so as to obtain a large tidal prism available for scour in the lower harbor and jetty channel; then at the end of a year or two, or when the new tidal prisms have done their work, it would be known what channel dredging would be required to enable the largest ships to enter the new harbor.

The report and recommendations of the Board in full is printed in the Annual Report of the Chief of Engineers for 1874, Part II, page 378 et seq.

Work on the jetties was begun in 1874. They were placed from 700 to 800 feet apart, and to prevent sand in storms from washing over and obstructing the channel between them they had to be raised to high-water level. The land for the tidal canal, which it was expected would be donated by the city of Oakland, had to be acquired by condemnation proceedings, which were not completed until 1884.

No natural scour has occurred, and Oakland Harbor, as it is to-day and as far as completed, consists of a channel 300 feet wide and 19,000 feet long, which has been dredged throughout its entire length to a depth of 20 feet at low water, and which extends from deep water in San Francisco Bay to Webster Street Bridge. This deep-water excavation covers an area of about 130 acres. In addition to the above dredging, a tidal basin covering an area of about 300 acres has been excavated to a depth of 2 feet below low water. In 1892–93 a channel 200 feet wide, 8 feet deep, and about 5,000 feet long was dredged on the north side of this basin. An excavation 3,800 feet long, 400 feet wide (generally), and to a depth of 8 feet below low water was made at the western end of the tidal canal, and one about 3,000 feet long to full width and depth was made at the eastern end of this canal. The latter has since refilled. As the tidal canal has never been completed, there has been no tidal flow from San Leandro Bay into Oakland Harbor.

The total cost of the work up to June 30, 1900, has been $1,944,925, and the total amount appropriated to date has been $2,450,000.

The commerce of Oakland Harbor has increased enormously during the twenty-six years in which the harbor has been in process of construction, as is illustrated by the following tables of statistics:

Year.	Traffic by ferries.		Traffic by vessels.		Total freight carried.
	Passengers.	Freight.	Number.	Freight.	
		Tons.		*Tons.*	*Tons.*
1874	....	60,000	1,415	94,800	154,800
1878	216,240	129,000	1,085	211,627	340,627
1888	200,000	1,876,635	1,384	295,932	2,172,567
1890	100,000	1,925,957	2,153	393,478	2,319,435
1891	100,000	2,259,086	2,310	437,923	2,697,009
1892	96,000	2,202,170	2,277	433,011	2,635,181
1893	506,126	2,142,460	1,686	306,860	2,449,320
1894	554,982	2,119,267	1,741	309,350	2,428,617
1895	335,868	2,188,908	1,966	249,788	2,438,696
1896	249,843	2,131,491	1,946	366,098	2,497,589
1897	248,160	2,288,171	1,352	340,660	2,628,831
1898	226,068	2,374,546	1,596	414,849	2,789,395
1899	186,360	2,890,249	1,660	363,966	3,254,215

It will thus be seen that commerce entering and leaving the harbor has increased from 154,000 tons in 1874 to about three and a quarter million tons in the calendar year 1899, or fully twentyfold. It is also observed that about 89 per cent of the above, and of which the greater portion is transcontinental freight, is carried by ferryboats drawing about 12 feet, more or less, of water; the other 11 per cent, amounting to about 364,000 tons, was carried on 1,660 vessels, or an average of about 213 tons per vessel. It is known, however, that some of these vessels carried and delivered upward of 2,000 tons of coal each; and a very great number of large vessels, which could not enter the harbor, had to discharge at what is known as the Long Wharf, which is about 2 miles in length, and extends from the Oakland shore into deep water of San Francisco Bay.

The San Francisco Chronicle of July 22, in an article on Oakland Harbor, stated that since January 1, 1900, 107 vessels from foreign countries, including the Hawaiian Islands, had docked at Oakland, of which number 87 docked at Long Wharf, the other 20 at docks inside Oakland Harbor. These vessels are reported to have landed 929,530 bags of sugar, mostly destined for the East, and 58,341 tons of coal. The duty on the coal amounted to nearly $39,000.

Oakland papers state that all shipping men agree that a channel having a least depth of 25 feet at low water is absolutely necessary to permit wheat ships, colliers, and other large vessels to use Oakland Harbor. It is also reported and claimed that, owing to the enormous increase in shipping arriving at San Francisco Bay and the present alleged inadequate wharf facilities there, Oakland Harbor must be further improved to accommodate such vessels as require quick dispatch and can not find wharf room at San Francisco.

At all events, while the harbor planned by the Board of 1874, excepting the tidal canal, is essentially completed, it is too small in depth, width, and length to accommodate the large class of vessels at present engaged in commerce.

With a view to ascertain what additional improvements were necessary, a circular letter was prepared and sent to the Board of Trade of Oakland and to prominent merchants engaged in shipping, requesting them to give their views as to the requirements of Oakland Harbor to meet the present and prospective needs of commerce. Only two replies have thus far been received, copies of which are appended.

Attention is especially invited to the letter of Mr. John L. Howard, who believes that the channel or harbor proper, extending from the east end of the jetties up to Fallon street (a length of about 2 miles) should be made about 250 feet wider, so as to embrace the whole water front of Oakland, and to have a least depth of 20 feet at low water, on completion of which it will meet the present needs of commerce and the prospective needs for at least a generation to come.

About one-half mile in length of the 2 miles above referred to, between the pierhead line and the existing channel, has already been dredged to a depth of 20 feet or more at private expense by the owners of the wharves, and projects heretofore made contemplated that all wharf owners would dredge a channel between their wharves and the existing channel. As the wharves are not continuous along the pierhead line, and as all wharf owners have not dredged from wharf to channel, the cuts already made will probably not be self-maintaining.

It is conceded that large vessels can not turn in a channel only 300 feet in width. A 500-foot wide channel is believed to be necessary for this harbor. Practically all the commerce of the harbor is handled on the Oakland side of the channel, but as the pierhead lines on the Oakland and Alameda sides are reasonably parallel to each other and about 750 feet apart, with the harbor or channel midway between them, there is practically as much room for development for wharves, warehouses, shipyards, manufacturing establishments, and industries of all kinds on the south or Alameda side as there is on the Oakland side. On account of the hardpan underlying the softer material on the Oakland side, while none is known to exist on the Alameda side, it will cost the Government much less to excavate a 500-foot wide channel by making cuts of equal width on each side of the present cut than to make the whole cut on the Oakland side.

If it was contemplated to make a channel 750 feet wide, extending from pierhead line on the Oakland side to the corresponding line on the Alameda side, it might then be proper to make the first cut for increased width on the Oakland side. All wharves on both sides of the harbor are held in private, corporate, or municipal ownership, and the owners desire or expect to receive a revenue from the same. It would therefore seem reasonable and proper that if the Government expends millions of dollars to excavate a channel or harbor 500 feet in width and about 4 miles in length owners of wharves ought to be expected to spend a few thousand dollars to connect the harbor with their wharves, especially when the edge of the channel is only about 125 feet distant, more or less, from the wharves.

Former officers in charge of this work have recommended increasing the width of the channel between the jetties to 500 feet, but have not recommended an increase of width in the harbor proper, probably because they believed wharf owners would, at private expense, increase the width to reach their wharves. As nearly all large vessels entering or leaving the harbor either tow or steam in and out, 300 feet wide might be wide enough for the present requirements of commerce; but as the jetty channel is over 2 miles in length accident in this channel might block all the commerce of the port.

It is believed that a channel 500 feet wide from San Francisco Bay to Fallon street, Oakland, is necessary and advisable. In addition to the above, the south jetty will probably have to be extended farther into San Francisco Bay to prevent shoaling at the outer end of the jetty channel. From Fallon street to the basin a channel 17 feet deep at low water, 300 feet wide, and all around the tidal basin a channel 300 feet wide and 12 feet deep at low water should be made. This will give direction to the tidal flow and probably aid in maintaining depth in the harbor below; besides, it will give access to a large part of Alameda on the south side of the tidal basin, which as yet has derived but little benefit from the improvement.

The tidal basin proper, covering an area of about 300 acres, was excavated to a depth of 2 feet below low water to increase the volume of tide with a view to maintain depths in the harbor below. The deepening of this basin throughout would furnish a magnificent inner harbor for vessels to lay up in, but would be expensive, and as there is plenty of room in San Francisco Bay for vessels lying at anchor dredging the tidal basin of Oakland Harbor is not recommended.

It may be necessary eventually to make a channel 25 feet deep at low water throughout Oakland Harbor. On account of its great increase in commerce it is worthy of further improvement. Surveys and borings will be required to estimate the cost of any improvement which may be recommended. Funds from the appropriation for "improving harbor at Oakland, Cal.," are available for the survey.

Oakland is a subport of entry and has a population estimated at 75,000.

Respectfully submitted.

W. H. Heuer,
Lieut. Col., Corps of Engineers.

Brig. Gen. John M. Wilson,
Chief of Engineers, U. S. A.

[First indorsement.]

Office Chief of Engineers,
U. S. Army,
August 3, 1900.

Respectfully submitted to the Secretary of War.

This is a report upon preliminary examination of Oakland Harbor, California, required by the emergency river and harbor act of June 6, 1900 (full text of item quoted within).

On account of the great increase that has taken place in the commerce of the harbor the local officer is of opinion that the locality is worthy of improvement, and I recommend that a survey be made and the cost of improvement be estimated, the expenses of the work to be paid from the appropriation for improving the harbor.

John M. Wilson,
Brig. Gen., Chief of Engineers,
U. S. Army.

[Second indorsement.]

War Department,
August 6, 1900.

Approved as recommended by the Chief of Engineers.

Elihu Root,
Secretary of War.

REPORT OF MR. L. J. LE CONTE, ASSISTANT ENGINEER.

United States Engineer Office,
San Francisco, Cal., July 20, 1900.

Sir: Your written instructions, dated July 11, 1900, inclosing a copy of the emergency river and harbor act of Congress of June 6, 1900, requiring a "preliminary examination to be made of Oakland Harbor, California, with a view to the improvement of said harbor to meet the needs of present and prospective commerce from the western end of the tidal canal to deep water in San Francisco Bay, including the excavation of a tidal basin," and calling upon me to make a suitable examination and report in conformity therewith, are received.

In compliance with your request I have now the honor to submit the following report:

ORIGIN OF THE WORK.

A Board of Officers was constituted by Special Orders, No. 32, headquarters Corps of Engineers, Washington, D. C., March 24, 1873, to wit:

"3. A Board of Officers of the Corps of Engineers, to consist of Lieut. Col. B. S. Alexander, Lieut. Col. C. S. Stewart, and Maj. G. H. Mendell, is hereby constituted for the purpose of making the examination and survey and plan of harbor at San Antonio

Creek, California, provided for in section 2 of the act making appropriation for rivers and harbors, approved March 3, 1873."

The Board, after due deliberation, handed in their report, dated February 16, 1874, and recommended a project, with plans and estimates for a commercial harbor. The scheme for improvement included the following works:

First. To build two parallel half-tide stone jetties 11,000 feet long, the channel way between them 1,000 feet wide, subject to subsequent contraction by spur dikes, if found necessary or advisable; also, to dredge a channel between the jetties 100 feet wide and 6 feet deep at low water; a low-water depth of 18 to 20 feet was expected to be developed by natural scour.

Second. The harbor proper between the jetties and the tidal basin. No work was contemplated in this division of the improvement, the presumption being that ample depth for commercial purposes would be obtained by natural tidal scour, free from cost and expense.

Third. The excavation of a tidal basin in the upper harbor to a uniform depth of 2 feet at low water, making its entire prism available for scour in the lower harbor and jetty channel.

But to insure ample tidal scour, and at the same time make and maintain adequate depths of water in the channels for commercial purposes, the Board proposed, in addition, the construction of a tidal canal, connecting San Leandro and San Antonio estuaries, the natural ebb and flow through the canal to be controlled by a suitable dam, situated at the mouth of San Leandro Bay, with automatic tide gates thereon. By this device they expected to double the natural tidal prism of San Antonio Estuary, and the scour thus induced would obviate a large amount of primary dredging and do away with the necessity of constant dredging in the future.

The order of work recommended was as follows:

First. Construct the two half-tide jetties and dredge the 100-foot channel 6 feet deep at low water; then—

Second. Excavate the canal between San Antonio Estuary and San Leandro Bay;

Third. Construct the dam at the mouth of San Leandro Bay.

Fourth. Excavate the tidal basin.

Then, after the expiration of one or two years, or when the new tidal prisms have done their work, one will know what channel dredging will be necessary to enable the largest ships to enter the new harbor.

This plan was apparently adopted July 10, 1874, and the work of improvement transferred to Maj. G. H. Mendell by letter of even date, and calling upon him for a project for the expenditure of the first appropriation, made by Congress June 23, 1874.

Congress has continued to make appropriations as follows:

June 23, 1874	$100,000
March 3, 1875	100,000
August 14, 1876	75,000
June 18, 1878	80,000
March 3, 1879	60,000
June 14, 1880	60,000
March 3, 1881	60,000
August 2, 1882	200,000
July 5, 1884	139,600
August 5, 1886	60,000
August 11, 1888	350,000
September 19, 1890	$250,000
July 13, 1892	150,000
August 18, 1894	100,000
June 3, 1896	20,000
June 4, 1897	200,000
July 1, 1898	133,000
March 3, 1899	133,000
June 6, 1900	180,000
Total	2,450,600

All work has generally been done by contract. As work progressed year by year many expectations were not realized, and as a result the details of the original project were greatly modified to meet new conditions. This was done from time to time as annual projects were submitted and approved.

The present condition of the harbor works may be described as follows:

First. Two slightly converging high-tide jetties extending from the shore line to 12-foot water at low tide in San Francisco Bay. The north jetty is 9,500 feet long, the south jetty 12,000 feet long. The width of the jetty channel at the inner end is 800 feet and at the outer end 730 feet near the mouth.

Second. A channel 20 feet deep at low water, 300 feet wide on the bottom, has been dredged from San Francisco Bay to Webster Street Bridge, a distance of 19,000 feet. Practically speaking, no work has been done between the Webster Street Bridge and the tidal basin, a distance of 5,500 feet.

Third. A large amount of dredging work has been done in the tidal basin, covering the entire natural basin and including the removal of a large marshy island and several projecting points of marsh land, all of which were granted by the owners free of expense. The basin embraces something over 800 acres. The depth obtained on completion of work was 2 feet at low water.

On the north side of the basin a channel has been dredged 5,000 feet long, 200 feet wide, and 8 feet deep at low water.

The above description includes everything done on the harbor works up to the west end of the canal. This work, with the exception of the tidal canal, the bridges at High street and Fruitvale avenue (both the latter now in process of erection), the dam and tide gates at the entrance to San Leandro Bay, essentially completes the project as recommended by the Board of 1873.

The amount expended on the work up to June 30, 1900, was $1,944,925.98.

In reply to your query, "What do you think is required in the way of additional improvement between the west end of the tidal canal and deep water of San Francisco Bay to meet the needs of present and prospective commerce?" I would say that I am of the opinion that the following itemized statement embraces all the additional improvements required to make Oakland a safe and commodious harbor for modern vessels:

First. A further extension of the south jetty into San Francisco Bay, amounting to 550 feet, will be necessary.

Second. The present 20-foot channel, extending from deep water in San Francisco Bay up to Webster Street Bridge, should be widened to 500 feet and deepened to 25 feet at low water, and extended in length easterly past the bridges as far as Fallon street. This would embrace the city front of Oakland proper.

East of Fallon street the deep-water channel should be continued, having a width of 300 feet and depth of 25 feet at low water, for a distance of about 2,500 feet to a point where it meets the tidal basin. East of this point the necessities of commerce require the construction of two channels, one skirting along the city front of Brooklyn and the other along the Alameda frontage. Both of these channels should be 300 feet wide and 25 feet deep at low water, and should extend easterly and finally unite at the west end of the tidal canal.

Third. That portion of the tidal basin which is encircled by the above-mentioned channels should be deepened about 3 feet, thus making a uniform depth of 5 feet at low water. The tidal basin has, of course, already received its full development as regards tidal prism, but it is largely used now as a winter harbor to accommodate whalers and fur sealers, who habitually lay up during the winter months.

To deepen the basin 3 feet would not cost much, and when completed will undoubtedly be of great benefit to certain classes of vessels.

FINAL REMARKS.

The above outline of additional improvements desirable will certainly entail the expenditure of a large amount of money, and the question naturally arises whether or not the local commercial interests, both present and prospective, justify the outlay.

In this connection we have as an object lesson the annual freight movement in this harbor previous to improvement, viz, 154,300 tons, as compared with the annual freight movement during the past year, 1900, viz, 3,254,215 tons. The total amount expended on the works up to June 30, 1900, was $1,944,925.98, showing an increased annual tonnage movement of 1.60 tons for each and every dollar spent on the harbor works. Few harbors can show a better record.

Respectfully submitted.

L. J. LeConte, C. E.,
Assistant Engineer.

Lieut. Col. W. H. Heuer,
Corps of Engineers, U. S. A.

LETTER OF MR. JOHN L. HOWARD.

The Pacific Coast Company,
San Francisco, Cal., June 22, 1900.

Dear Sir: In answer to your letter of June 20, I give you an opinion based upon experience and observation with the water front of the city of Oakland during the past twenty years, and it is from a commercial and not from an engineering point of view.

The present condition is that the Government has completed a channel 20 feet in depth at low tide and 300 feet in width from a point in San Francisco Bay, and extending eastwardly between the training walls and along the Oakland water front to Webster Street Bridge.

Beyond this bridge to Alice street the channel is not so deep, and to the eastward beyond Alice street the mid-channel is so shallow as to be practically useless for commercial purposes. Between Alice and Fallon streets the owner of the shore property has made it available by digging a ditch 200 feet in width to admit deep-water ships at his wharf. Fallon street may therefore be considered the present eastern limit of commerce.

I do not know whether additional dredging westward from the western end of the tidal canal is an engineering necessity for the completion of the purpose for which the canal is being built, but if it is not, then the question would seem to resolve itself into the best application of governmental appropriations to meet the commercial needs of Oakland.

From the eastern end of the training walls to Fallon street the Oakland water front is approximately 2 miles in length, and nearly all of this is absolutely valueless for deep-water shipping, because between the upper edge of the present channel and the pierhead line the distance is about 250 feet. At the pierhead line the bottom is bare at low tide. It therefore follows that until this bank be cut away along the length of Oakland water front the city can not avail itself of the present channel, to say nothing of a deeper one. As the matters present themselves to me in the order of their importance, and considering the intervals that elapse between appropriations, the needs are, viz:

1. To widen the channel between the limits above referred to so that in front of the city there shall be a basin extending outward 550 feet in width from the pierhead line (including the present channel), and of a uniform depth of 20 feet at low tide. This would give the greatest relief in the shortest time to the largest number of interests, and it will take a long period for Oakland to tax the capacity of its wharf frontage when so improved.
2. If the city rises to her commercial opportunities, then in order to accommodate the increasing size of ocean-going vessels the channel from the bay to the foot of Fallon street, and including the area between the present channel and the Oakland pierhead line, should be deepened to 25 to 30 feet at low tide.
3. After the accomplishment of these immediately necessary matters, then attention might be devoted to the easterly extension of the channel.

I think it self-evident that if the Oakland water front were now deepened from the pierhead line outward to a uniform depth of 20 feet at low tide, a landlocked harbor would be created without an equal on the Pacific coast, and, in so far as the prospective needs of commerce are concerned, this 2 miles of frontage so made available will completely settle the question for at least a generation.

Yours, truly,

JOHN L. HOWARD.

Lieut. Col. W. H. HEUER,
Engineer Corps, U. S. A.

LETTER OF MESSRS. BALFOUR, GUTHRIE & CO.

SAN FRANCISCO, CAL., *June 23, 1900.*

DEAR SIR: We are in receipt of your favor of the 20th instant, and beg to state that Mr. John L. Howard informs us he received a similar communication from you and has shown us his reply, which deals so fully with the case that we entirely indorse his conclusions, which we trust will receive your favorable recommendation.

The improvements we have made on Oakland Creek are with the view of discharging and loading vessels with a draft of up to 23 feet, but as it is essential they should always lie afloat you will doubtless realize the importance of deepening the channel to not less than 25 feet at low water. At present large vessels must be lightened before they can safely enter the channel, which involves a heavy expense and is a drawback to the expansion of commerce in Oakland Harbor.

Yours, truly,

BALFOUR, GUTHRIE & CO.

Lieut. Col. W. H. HEUER, U. S. A.

LETTER OF OAKLAND BOARD OF TRADE.

OAKLAND, CAL., *July 30, 1900.*

DEAR SIR: In response to your communication of June 6, 1900, concerning proposed "examination and report of Oakland Harbor, with a view to the improvement of the same, etc.," the Oakland Board of Trade would respectfully submit for your consideration the following recommendations and suggestions:

In furtherance of the projected improvement we deem the following to be desirable and necessary in the order mentioned:

First. Cleaning out of the main channel adjacent to and below the bridges, where shoaled by slides or other accumulation, so as to furnish the full 20 feet at low tide. This is immediately necessary in order to get the benefit of the dredging already done; is a work of no magnitude, but of great importance.

Second. The deepening of the main channel from the bay to the mouth of Brooklyn Basin to 25 feet at low tide, thus permitting deep-water vessels to enter and depart with full cargoes and also accommodating the rapidly growing commerce of the Pacific. At present ships can partially load, and incoming vessels are compelled to lighter.

Third. Deepening to 15 feet at low tide of the channel dredged by Colonel Mendell in front of East Oakland and also continuing the same to the mouth of tidal canal at a depth sufficient to accommodate the flow of water from the canal, and thus prevent the sluicing of the mud in Brooklyn Basin down into the main channel to the detriment of work already done.

Fourth. Widening of the main channel at points necessary to permit the turning of large vessels. This is necessary, as vessels at present are oftentimes compelled to be towed out stern first, exposing them in the long tow in the narrow channel to the winds, especially when they are light and high out of the water.

Fifth. The completion of the deepening to 30 feet at low tide of the main channel from San Francisco Bay to the Brooklyn Basin and the widening of same. This is made necessary by the constantly increasing depth and length of vessels.

Sixth. The dredging of the Brooklyn Basin.

We would also recommend the readjustment of pierhead lines where circumstances will permit, so as to furnish greater length of piers to accommodate the constantly increasing length of vessels of modern construction.

Also that some dredging be done in San Leandro Bay, adjacent to the entrance to tidal canal, to prevent the passage of mud into the canal.

Also the diversion of San Leandro Creek directly into San Francisco Bay, thereby reducing the débris and accumulation of mud in said San Leandro Bay. This can easily be accomplished at a point in section 28, township 2 south, range 3 west.

We would also suggest that the report include a recommendation that the work be done under continuing-contract plan as being most expedient and economical.

Respectfully submitted.

OAKLAND BOARD OF TRADE,
E. W. MARSTON, *President.*
CRAGIE SHARP, *Secretary.*

Col. W. H. HEUER,
Corps of Engineers, U. S. A.

LETTER OF MR. E. C. SESSIONS.

OAKLAND, CAL., *July 30, 1900.*

DEAR SIR: Referring to the recommendation made by the Oakland Board of Trade relating to the diversion of the waters of San Leandro Creek into San Francisco Bay, I beg herewith to submit a tracing[1] taken from Allardt's original survey of tide lands, 1868 and 1870, showing the point referred to, where the creek approaches very near to tide waters of San Francisco Bay.

The question of admissibility and desirability of making any changes in either pierhead or bulkhead lines, to which reference was made in this committee report, is a matter which may in some places involve important engineering problems. Conclusions, therefore, should be determined solely in accordance with the judgment of the commission and be based upon their effect upon entire harbor plan.

In the presentation of this subject to the committee I personally had in view the appropriateness of its applicability to portions of Brooklyn Basin where there would appear to be no probable engineering objections.

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[1] Not printed.

I would therefore respectfully call your attention to the desirability of providing for longer piers in Brooklyn Basin where practicable and not in conflict with the general plan, as such action will without doubt add greatly to the value and extent of shipping accommodations in this locality.

The location of the line of the present channel in front of East Oakland by Colonel Mendell would seem to have been made largely with reference to the then existing natural channel, as well as the limited character of the improvement contemplated in front of East Oakland, which apparently treated the basin principally as a tidal prism.

The dredging out of the point of marsh land which originally existed in the basin, and the present contemplated further improvement of the Brooklyn Basin and channel, would seem to permit the consideration of the extension of the pierhead lines with apparently little or no ground for objection. Such extension would in fact relieve the Government of cost of dredging an area equal to that covered by the extension. For instance, between Twelfth and Eighteenth avenues the location of the railroad right of way is so near the bulkhead line as to greatly restrict the area inside the bulkhead, especially when it is considered that a street or driveway on the south side of the railroad track and parallel thereto will be necessary for the accommodation of traffic; this right of way and street way preventing the deepening of slips by extending them inland from the bulkhead, as may be practicable in some other portions of the basin.

Respectfully submitted.

E. C. Sessions.

Col. W. H. Heuer.

LETTER OF MR. EDSON F. ADAMS.

Oakland, Cal., *August 1, 1900.*

Dear Sir: I have delayed replying to your communication of June 20, in order to discuss the matters with members of the committee of the Oakland Board of Trade, of which I am a member.

I now respectfully make the following suggestions, and consider them of importance in the order named:

First. Cleaning out the 20-foot channel from the bay of San Francisco, where shoaled by slides or other causes, to the Webster Street Bridge, and extending the same to Fallon street if produced southerly. This will give the full benefit of the work already completed. A large portion of the shipping business is at present done above the bridges, and for that reason the channel should be extended.

Second. The deepening of main channel from the bay to the mouth of Brooklyn Basin to 25 feet at low tide, thus permitting deep-water vessels to enter and depart with full cargoes, and also accommodating the rapidly growing commerce of the Pacific. At present ships can but partially load, and incoming vessels are compelled to lighter.

Third. Deepening to 15 feet at low tide of the channel dredged by Colonel Mendell in front of East Oakland, and also in case of completion of tidal canal, said channel should be continued to mouth of the tidal canal at a depth sufficient to accommodate the flow of water from the canal, and thus prevent the sluicing of the mud in the Brooklyn Basin down into the main channel, to the detriment of the work already done.

Fourth. Widening of the main channel at points necessary to permit the turning of large vessels. This is necessary as vessels at present are oftentimes compelled to be towed out stern first, exposing them in the long tow in the narrow channel to the winds, especially when they are light and high out of the water.

Fifth. The completion of the deepening to 30 feet at low tide of the main channel from San Francisco Bay to Brooklyn Basin, and the widening of the same to at least 500 feet. This is made necessary by the constantly increasing depth and length of vessels.

Sixth. The dredging of the Brooklyn Basin.

Respectfully submitted.

Edson F. Adams.

Col. W. H. Heuer,
Corps of Engineers, U. S. A.

SURVEY OF OAKLAND HARBOR, CALIFORNIA IMPROVEMENT FROM THE WESTERN END DEEP WATER IN SAN FRANCISCO BAY, INC OF TIDAL BASIN.

UNITED STATES EN
San Francisco, C

GENERAL: In the report submitted July 2 nary examination of Oakland Harbor, Calif improvement of said harbor to meet the need tive commerce from the western end of the in San Francisco Bay, including the excava provided for in the emergency river and har was stated that on account of the great increa Harbor was worthy of further improvement. the cost of the improvement borings became authorized and have been completed. Base such other data as became available, alternat ment of the harbor to different depths and wi and are submitted herewith.

Up to the present time Congress has appro ment of Oakland Harbor, California, $2,450, unexpended balance of $383,773.08 yet rem the completion of the tidal canal. Excepting of the south jetty and some other work, such which may not be necessary, the harbor as d Engineers in 1874 is essentially completed.

Reference to the tidal canal is herein ma indicated in recent appropriations for the ha out the "existing project," of which the ti because of its relation to other parts of the why it has not been completed. When the E accordance with the requirements of Congr Oakland Harbor, it provided for a tidal ca waters of San Leandro Bay with those of Oa that the increased tidal flow thus to be obtain rially aid in producing by scour increased de but would also maintain said depths.

The land which the tidal canal was to occup demnation and cost the Government $39,60 from the time proceedings began before final

The court decreed that the Government sh at its expense, suitable railway and highway railways and highways. At that time there w two railways crossing the line of the propo feet long, to a depth of 8 feet below low tide in width, was made at the west end of the ti about 3,000 feet in length, 400 feet in width, below water level was dredged at the east en of which has refilled. Then a steel highway the canal at Park street; another steel high completed at High street; a combined steel rail is now in course of erection, and nearly com at Fruitvale avenue, and for upward of a ye progress with the Central Pacific Railway Company with a view to purchase from that company a release from building a steel railroad bridge which would run diagonally across the canal at Washington avenue.

As there is daily train traffic over the routes to be occupied by the railway bridges, it would require the construction of temporary tracks, so as not to interfere with traffic, at additional expense to the Government, before permanent bridges could be built, or else serious interference with navigation pending their construction, and as there was a possibility that for a reasonable monetary consideration we might avoid the necessity of building, operating, and maintaining one expensive steel railway bridge across the tidal canal at Washington avenue, the matter of completing the tidal canal had to be deferred until the matter of this bridge could be finally disposed of. In the meantime the city of Alameda had constructed its sewers with outfalls near the junction of the tidal basin with the tidal canal. This created an immense cesspool, produced horrible stenches, and the people of Alameda have been clamoring to Congress ever since to complete the tidal canal.

Its estimated cost, revised up to 1887, was:

Tidal canal	$413,442
Dam at San Leandro end	27,000
Bridges across canal	200,000
Total	640,442

The expenditures on account of the tidal canal to date have been about as follows:

Land-condemnation award	$39,600
Dredging at both ends of canal	202,711
Cost of three bridges across canal	141,506
Diversion of Sausal Creek from canal	53,748
Total	437,565

It will be observed that the emergency river and harbor act of June 6, 1900, limits the examination of Oakland Harbor with a view to its improvement between the western end of the tidal canal and deep water of San Francisco Bay, including the excavation of a tidal basin; hence no borings were made, nor are any estimates submitted, for any work outside of the limits specified.

EXCAVATION OF A TIDAL BASIN.

The tidal basin, covering an area of about 300 acres, is situated at the eastern or upper end of Oakland Harbor, at its junction with the western end of the tidal canal. It was excavated to a depth of 2 feet below the level of low tide, and its sole object was to form a tidal basin, or reservoir, to be filled during flood tides and emptied during ebb, the outflow to aid in producing and maintaining necessary depths in the harbor below until such time as the tidal canal connecting this basin with San Leandro Bay should be completed. Thereafter the much larger tidal area of San Leandro Bay would become available for tidal scour.

The tidal basin has partially served its purpose, though some little filling has occured throughout its area. On the north side, where a channel was dredged 300 feet wide to a depth of 8 feet below low-tide level, the banks have in some places fallen down, and some little shoaling has occurred. Some of the material carried in by flood tides has been swept into the wide, shallow basin, and has necessarily been deposited there. When the tidal canal is cut through, and the tide waters of San Leandro Bay shall be diverted through it, additional deposits on the ebb tide are likely to occur in the basin. To maintain a good circulation of tide water in and around this basin, and at the same time to afford additional harbor facilities, should any be required, to the towns of Brooklyn and Alameda, it is believed that a channel 300 feet wide and 12 feet deep at low tide should be dredged entirely around the tidal basin. The volume to be excavated is 100,000 cubic yards of hardpan, and 1,746,166 cubic yards of mud, making a total of 1,846,166 cubic yards, which is estimated to cost $144,769.

The tidal basin itself, besides being a tidal reservoir, is used as an anchorage ground or boneyard for light-draft vessels. As additional depth in this basin can not add to the scouring effect, and would only furnish anchorage ground for deeper-draft vessels, and would cost considerable money, and as there is ample anchorage ground in the adjacent waters of San Francisco Bay, a deepening of the basin throughout its area is not deemed necessary.

As the commerce of Oakland Harbor is gradually growing and extending east of Webster Street Bridge, it is believed that the existing channel between Fallon street and the tidal basin should be made 300 feet in width and 17 feet in depth at low water. This will involve the removal of 300,000 cubic yards of mud, estimated to cost $18,000.

From Fallon street to deep water of San Francisco Bay, a distance of about 4 miles, a channel 300 feet wide is too narrow for vessels drawing 20 feet or more of water to turn in.

The existing channel is 300 feet wide, 20 feet deep at low water, about 19,000 feet in length, and extends from deep water in San Francisco Bay to Webster Street Bridge. To increase this channel to a width of 500 feet, and extend same up to Fallon street, is estimated to cost $345,325.

To maintain a channel of this width and depth it will be necessary to extend the south jetty into San Francisco Bay about 550 feet in a westerly direction, at an estimated cost of $53,900.

The improvement, which it is believed the present and prospective commerce of Oakland Harbor needs (west of the tidal canal), is a channel 500 feet wide and 20 feet deep at low water, extending from deep water in San Francisco Bay to Fallon street; thence a channel 300 feet wide and 17 feet deep to the tidal basin, and then a channel entirely around the basin 300 feet wide and 12 feet deep, the estimate for which is shown in detail as estimate No. 1, herewith.

In connection with the above estimate it must be said there is a very strong feeling among many of the prominent business men of Oakland that a 20-foot depth of channel in this harbor is insufficient for the requirements of commerce. It is true that when the harbor was planned in 1874 the number of vessels engaged in commerce on this coast drawing more than 24 feet of water was very limited. The population of Oakland has increased, being now a little less than 70,000.

The tonnage or commerce entering Oakland Harbor has increased something like twentyfold, and now exceeds three millions of tons per year. Of this amount, however, about 89 per cent is transcontinental railway freight, which only passes through Oakland in cars, and which enters and leaves Oakland Harbor on ferry or transit boats, drawing, when laden, about 12 feet of water. Vessels drawing more than 20 feet can not enter the harbor at low water, and have to be lightered to enable them to reach the wharves.

What the aggregate cost of this lighterage amounts to per year has not been ascertained. If the cost of the lighterage should be greater than the interest on the cost of the improvement necessary to obtain the increased depth, and should affect a large portion of the community, it might be a good reason for making a harbor of increased depth.

Vessels too deep to enter Oakland Harbor can get their cargoes into the city of Oakland by unloading at the Long Wharf near the Oakland Mole, upon paying wharfage and tolls for hauling cargo over the wharf. In fact, all vessels entering Oakland Harbor are charged tolls for lying and unloading at the wharves in the harbor.

Those who might be largely benefited by increased depth of channel would be the wharf owners or lessees. Most of the increased depth in existing channels would have to be made by excavation in hardpan, and would be quite expensive.

Estimate No. 1, for channels therein specified, amounting to $646,293, is believed to be sufficient for the existing commerce and that for many years to come for Oakland Harbor west of the tidal canal. Other estimates for deeper channels of dimensions therein stated are furnished in estimates Nos. 2 and 3, herewith.

Estimate No. 1, Oakland Harbor.

Channel 500 feet wide and 20 feet deep at low water, from San Francisco Bay to Fallon street, Oakland; thence 300 feet wide and 17 feet deep to tidal basin; thence 300 feet wide and 12 feet deep around tidal basin:

San Francisco Bay to Fallon street—	
481,699 cubic yards hardpan, at 40 cents	$192,680
725,182 cubic yards sand, at 10 cents	72,518
1,335,460 cubic yards mud, at 6 cents	80,127
Fallon street to tidal basin (300 by 17 feet)—	
300,000 cubic yards mud, at 6 cents	18,000
Channel around tidal basin (300 by 12 feet)—	
100,000 cubic yards hardpan, at 40 cents	40,000
1,746,166 cubic yards mud, at 6 cents	104,769
Extension of south jetty westward 550 feet	53,900
	561,994
Add 15 per cent for contingencies	84,299
Total	646,293

Estimate No. 2, Oakland Harbor.

Channel 500 feet wide and 25 feet deep from San Francisco Bay to Fallon street; thence 300 feet wide and 25 feet deep up to and around basin:

Channel 500 by 25 feet, San Francisco Bay to Fallon street—	
1,304,613 cubic yards hardpan, at 40 cents	$521,845
1,402,373 cubic yards sand, at 10 cents	140,237
1,176,770 cubic yards mud, at 6 cents	70,606
Channel 300 by 25 feet, Fallon street up to and entirely around basin—	
1,201,369 cubic yards hardpan, at 40 cents	480,547
3,342,239 cubic yards mud, at 6 cents	200,534
Extension of south jetty 550 feet	53,900
	1,467,669
Add 15 per cent for contingencies	220,149
Total	1,687,818

Estimate No. 3, Oakland Harbor.

Channel 500 feet wide and 25 feet deep to Chestnut street; thence 300 feet wide and 25 feet deep to Fallon street; thence 300 feet wide and 17 feet deep to tidal basin; thence 300 feet wide and 12 feet deep around tidal basin:

Channel 500 by 25 feet, San Francisco Bay to Chestnut street—	
792,603 cubic yards hardpan, at 40 cents	$317,041
989,038 cubic yards sand, at 10 cents	98,903
512,336 cubic yards mud, at 6 cents	30,740
Channel 300 feet wide and 25 feet deep to Fallon street—	
419,536 cubic yards hardpan, at 40 cents	167,814
179,150 cubic yards mud, at 6 cents	10,749
Channel 300 feet wide and 17 feet deep to tidal basin	18,000
Channel 300 feet wide and 12 feet deep around tidal canal	144,769
Extension of south jetty	53,900
	841,916
Add 15 per cent for contingencies	126,287
Total	968,203

Respectfully submitted.

W. H. HEUER,
Lieut. Col., Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers U. S. A.

U U 13.

EXAMINATION AND SURVEY OF SAN JOAQUIN RIVER, CALIFORNIA, AND THE WATERWAYS CONNECTING THE SAME WITH THE STRAIT OF KARQUINES.

[Printed in House Doc. No. 261, Fifty-sixth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, December 20, 1900.

SIR: I have the honor to submit the accompanying copies of reports dated, respectively, August 21 and December 12, 1900, by Lieut. Col. W. H. Heuer, Corps of Engineers, upon preliminary examination and survey, made to comply with the provisions of the emergency river and harbor act of June 6, 1900, of San Joaquin River and the waterways connecting the same with the Strait of Karquines, extending from the town of Antioch to Suisun Point.

The town of Antioch is situate on the San Joaquin River about 4 miles above its mouth. About 4 miles below Antioch the mouths of the Sacramento and San Joaquin rivers join and together flow into the easterly end of Suisun Bay, the distance from this point in the bay to Suisun Point being about 16 miles in a westerly direction.

It appears from Colonel Heuer's survey report that the least depth in that portion of the bay under consideration is fully 13 feet and the least width 833 feet. He states that this depth is fully 3 feet greater than the least channel depths in the San Joaquin River up to Stockton and 6 feet greater than the least channel depths in the Sacramento River below Sacramento, and that the existing depths in the bay are ample for the commerce now using the waterway or that is likely to use it for several years to come. For the reasons presented by him it is his opinion that the improvement of the waterway is a work not necessary to be undertaken by the General Government.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

Hon. ELIHU ROOT,
Secretary of War.

PRELIMINARY EXAMINATION OF SAN JOAQUIN RIVER AND THE WATERWAYS CONNECTING THE SAME WITH THE STRAIT OF KARQUINES, EXTENDING FROM THE TOWN OF ANTIOCH TO SUISUN POINT, CALIFORNIA.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., August 21, 1900.

GENERAL: In compliance with the emergency river and harbor act of June 6, 1900, and your instructions of June 13, 1900, I have the honor to submit the following report of a preliminary examination of "the San Joaquin River and the waterways connecting the same with the Strait of Carquines [Karquines], extending from the town of Antioch to Suisun Point," California:

The town of Antioch is situated on the south or left bank of the San Joaquin River about 4 miles above its mouth. About 4 miles below Antioch the mouths of the Sacramento and San Joaquin rivers join and together flow into the easterly end of Suisun Bay, from which point of junction to Suisun Point, which is about 16 miles distant in a westerly direction, a navigable channel from one-eighth to one-half a statute mile in width and with depths varying from 6.5 feet at low tide in the shoalest part to 4 and 5 fathoms in the deepest part, extends through Suisun Bay and is used by all vessels plying between the Sacramento and San Joaquin rivers and the waters of San Francisco Bay.

Suisun Bay is about 16 miles in length and has a maximum breadth of about 5 miles, and in it are found numerous low, flat islands, some of them 3 to 4 miles in length and from 1 to 2 miles in width, which are generally cut through by sloughs. The land on the shores of the bay is generally low, flat, and marshy, very much of it subject to overflow. The highlands are seldom within a mile of the shores and in some places nearly 10 miles distant.

Its tidal area is approximately 30 square miles, of which perhaps nearly one-half has a low-water depth not exceeding 4 feet. The extreme tidal range is about 7 feet.

The Coast Survey chart of this bay, issued in 1883, made from topography executed in 1856 to 1866 and of hydrography executed between the years 1866 and 1878, shows a practicable channel through Suisun Bay from the Strait of Karquines into the Sacramento and San Joaquin rivers having a least depth of 13 feet at mean low tide, and at only two localities, each a half mile or less in length, was the depth then less than 16 feet. Steamboat men who now navigate Suisun Bay assert that a very considerable part of the channel between Point Edith and Stake Point, which are about 7 miles apart, has numerous shoal places where the depth at low water does not exceed 6.5 feet and in which the channel is very narrow and crooked.

Assuming this to be a fact, it would indicate that in the past twenty-two years a shoaling of from 6.5 to 9.5 feet has occurred over parts at least in the channel depths of the bay. It is also asserted that some shoaling has occurred in portions of New York Slough, which is about 3 miles in length, affords a short cut from Suisun Bay into the San Joaquin River, and is used by all boats which ply on the latter river. This slough has two small towns, known as New York Landing and Pittsburg Landing, on its south bank.

As the San Joaquin and Sacramento rivers are both sediment-bearing streams and drain a territory exceeding 28,000 square miles, it is not surprising that a considerable deposit of such sediment should occur below their mouths in Suisun Bay. It is probable that all the islands, together with the low, flat, marshy lands within and along the shores of Suisun Bay, are sedimentary deposits from these rivers.

Antioch is a small town, having a paper-manufacturing establishment within its limits, and two lines of railroad between Stockton and San Francisco have stations in or near the town. The principal articles shipped from there are paper, fish, grain, and fruit. Stockton, some 50 miles up the river, on a slough or channel called Stockton Channel, is quite a city of growing commercial, agricultural, and manufacturing importance.

For the improvement of the San Joaquin River $451,500 has been appropriated and for the improvement of the Sacramento River $850,000 has been appropriated by Congress, to obtain and maintain channels of sufficient depth and width to accommodate the commerce of these rivers, aggregating annually a trifle less than 1,000,000 tons. The channel depth endeavored to be maintained in the San Joaquin River below Stockton is 9 feet at low tide. Owing to the large area of Suisun Bay there is frequently considerable swell, and sometimes waves several feet in height in its channels, and vessels that would require a 9-foot depth of channel in the river should have 2 to 3 feet greater depth through Suisun Bay. It is assumed that a low-water channel depth of 12 feet, with a least width of 200 feet, will be necessary for the commerce passing through Suisun Bay.

To determine the best method of obtaining and maintaining the proposed channel, whether by dredging or by dikes, or by both combined, and the probable cost of same, it will be necessary to make a hydrographic survey, covering approximately 17 miles of channel area, which is estimated to cost about $1,700. It is doubtful if funds appropriated for the improvement of San Joaquin River can properly be applied for the purpose of a survey beyond the mouth of the river. On this point instructions are requested. If available they can be spared from the appropriation.

The commerce passing through the channel of Suisun Bay, which includes all that enters and leaves the San Joaquin and Sacramento rivers, is so great as to make this waterway worthy of improvement.

Respectfully submitted.

W. H. HEUER,
Lieut. Col., Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY.
August 30, 1900.

Respectfully submitted to the Secretary of War.

This is a report upon preliminary examination of San Joaquin River, California, and the waterways connecting the same with the Strait of Karquines, extending from the town of Antioch to Suisun Point, required by the emergency river and harbor act of June 6, 1900.

On account of the importance of the commercial interests involved, the waterway is reported to be worthy of improvement by the General Government, and I recommend that a survey be made and the cost of improvement be estimated.

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

[Second indorsement.]

WAR DEPARTMENT,
August 31, 1900.

Approved as recommended by the Chief of Engineers.

By order of the Secretary of War.

JOHN C. SCOFIELD,
Chief Clerk.

SURVEY OF SAN JOAQUIN RIVER AND THE WATERWAYS CONNECTING THE SAME WITH THE STRAIT OF KARQUINES, EXTENDING FROM THE TOWN OF ANTIOCH TO SUISUN POINT, CALIFORNIA.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., December 12, 1900.

GENERAL: The emergency river and harbor act of June 6, 1900, provided for a preliminary examination of "the San Joaquin River and the waterways connecting the same with the Strait of Carquines [Karquines], extending from the town of Antioch to Suisun Point," California. This preliminary examination was made by me and reported on under date of August 21, 1900.

The waterways which connect the San Joaquin River with the Strait of Karquines are part of what is known as Suisun Bay, which covers a tidal area of approximately 30 square miles. All the commerce passing into and out of the San Joaquin and Sacramento rivers, Bay.

The average annual amount of tonnage passing through this waterway in the past nine years has been 808,605 tons. The minimum in any one year was 653,655 tons, and the maximum was a little more than 1,000,000 tons.

The published United States Coast Survey chart of Suisun Bay shows that the hydrography thereon was determined by surveys made in 1866 and 1878, and the least channel depths shown are between Point Edith and Roe Island, just north of the mouth of Hastings Creek, where 15 to 16 feet was found over a shoal approximately 2,000 feet in length, and over another shoal to the eastward of Middle Point, where depths of 13 to 14 feet could be carried at low tide over a shoal approximately 2,500 feet in length.

Some of the steamboat men navigating this part of the bay informed me in August of 1900 that the depths on these shoals had decreased until the channel depths at low water did not exceed 6.5 feet, and that the channel is narrow and crooked.

As there is much fog in Suisun Bay, as the channel is wide, the islands and shore line low and flat, and as there is frequently considerable sea running in this bay, and as the Government had spent about one and a quarter million dollars in improving and maintaining the rivers emptying into this bay, it became important to make a resurvey of this waterway with a view to determine the location and amount of shoaling, and to enable plans and estimates to be made to improve the channels in Suisun Bay in case such should be necessary.

The survey was made under my direction by Mr. Laurence Thompson, junior engineer, and assistants, during September, October, and November, 1900. Mr. A. F. Rodgers, assistant in charge of the United States Coast and Geodetic Survey, kindly furnished descriptions of bench marks with reference to the low-water plane, so that our work could be connected with theirs. The result is shown on the two sheets herewith[1] on a scale of 1:10,000, and is exceedingly gratifying in the fact that at the two localities between Point Edith and Stake Point where shoals existed in 1866 and 1878 we find channel depths essentially the same now as then. The least depth anywhere on these shoals is fully 13 feet, and the least width is 833 feet. As this depth is fully 3 feet greater than the least channel depths in the San Joaquin River up to Stockton, and 6 feet greater than the lea channel depths in the Sacramento River below Sacramento, it is believ to be ample for the commerce now using or likely to use this waterw for several years to come.

It is my opinion, based on this survey and the facts as stated, no improvement of the waterway connecting the San Joaquin with the Strait of Karquines is necessary.

Respectfully submitted.

W. H. Heue
Lieut. Col., Corps of Eng

Brig. Gen. John M. Wilson,
Chief of Engineers, U. S. A.

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[1] Not printed.

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PRELIMINARY EXAMINATION OF SAN JOAQUIN RIVER, CALIFORNIA, ABOVE THE MOUTH OF THE STANISLAUS RIVER, WITH A VIEW OF DETERMINING THE ADVISABILITY OF CLOSING THE MOUTHS OF THE MORE IMPORTANT BLIND SLOUGHS LEADING FROM SAID SAN JOAQUIN RIVER AND TRIBUTARIES, ESPECIALLY THOSE KNOWN AS FINEGAN, AMPHLET, AND WALDEN SLOUGHS, THAT THE WATER IN THE MAIN CHANNEL OF THE SAID SAN JOAQUIN RIVER MAY BE RETAINED THEREIN AND MORE EFFECTUALLY PROMOTE NAVIGATION THEREOF.

[Printed in House Doc. No. 69, Fifty-sixth Congress, second session.]

Office of the Chief of Engineers,
United States Army,
Washington, November 21, 1900.

Sir: I have the honor to submit, for transmission to Congress, copy of report dated September 11, 1900, by Lieut. Col. W. H. Heuer, Corps of Engineers, upon preliminary examination of San Joaquin River, California, authorized by the emergency river and harbor act approved June 6, 1900, as follows:

> San Joaquin River, above the mouth of the Stanislaus River: With a view of determining the advisability of closing the mouths of the more important blind sloughs leading from said San Joaquin River and tributaries, especially those known as Finegan, Amphlet, and Walden sloughs, that the water in the main channel of the said San Joaquin River may be retained therein and more effectually promote navigation thereof.

Very respectfully, your obedient servant,

John M. Wilson,
Brig. Gen., Chief of Engineers,
U. S. Army.

Hon. Elihu Root,
Secretary of War.

REPORT OF LIEUT. COL. W. H. HEUER, CORPS OF ENGINEERS.

United States Engineer Office,
San Francisco, Cal., September 11, 1900.

General: In compliance with the emergency river and harbor act, approved June 6, 1900, and your instructions relating to same, I have the honor to report on an examination of the "San Joaquin River, above the mouth of the Stanislaus River, with a view of determining the advisability of closing the mouths of the more important blind sloughs leading from said San Joaquin River and tributaries, especially those known as Finegan, Amphlet, and Walden sloughs, that the water in the main channel of the said San Joaquin River may be retained therein and more effectually promote navigation thereof."

The river and harbor act of July 13, 1892, provided for "preliminary examination of San Joaquin River, California, from Hills Ferry to Firebaughs Ferry, including the closing of sloughs on the river above Stockton." The examination was made by myself and fully reported on in the Annual Report of the Chief of Engineers for 1893, pages 3290 and following. The conclusion reached was that the closure of the sloughs would not reduce freight rates, would not permit of low-water navigation, nor materially prolong the season of high-water navigation, and that the portion of the river between Firebaugh and Hills Ferry was not worthy of improvement.

The next preliminary examination of the San Joaquin River was made in compliance with the river and harbor act of August 18, 1894, which required an examination of the "San Joaquin River, above the mouth of Stanislaus River, with a view to improvement, including closure of sloughs to a height sufficient to maintain current in main channel during low-water period."

The examination was made by Lieut. Herbert Deakyne, Corps of Engineers, who passed along and inspected all the sloughs (including Finegan, Amphlet, and Walden sloughs) below Firebaugh, down as far as the Stanislaus River, which is upward of 50 miles below Hills Ferry. The report of the examination is printed in the Annual Report of the Chief of Engineers for 1896, pages 3219 and following. It was concluded that the low-water flow of the river was too small to permit of any improvement for low-water navigation; that in high-water stages there was water enough to enable boats to reach Firebaugh, the practicable head of navigation, and carry whatever freight offered; that during medium stages of river boats could not reach Firebaugh, and that there was not sufficient commerce on the river to warrant the expenditure of money to make the river navigable at such stage, even if it were practicable, and that the closure of all the sloughs coming into the river above the mouth of the Stanislaus would not maintain a current in the river above Hills Ferry during low-water period; that the closure of the sloughs would cause the river to break its banks at other places, and that, finally, except in the removal of snags, the river above the mouth of the Stanislaus was deemed unworthy of improvement.

The third and most recent examination, in compliance with the act of Congress of June 6, 1900, was made by Assistant Engineer H. L. Demeritt, whose full report is herewith. He examined not only Walden, Finegan, and Amphlet sloughs, those mentioned in the act of Congress, but other important sloughs between Firebaugh and the mouth of the Stanislaus River. The few towns, landings, and the sloughs are described. With reference to the sloughs, it is known that where some of them leave the river the bottom of the sloughs are 5 to 6 feet above low-water surface of the river, and hence water can not flow from the river into such sloughs until the river is about 5 feet above its low-water stage. As the boats which use the river do not draw to exceed 3 feet of water, the closure of sloughs in such condition is not necessary in the interest of navigation. Other sloughs leave the river at or near low-water level, which causes a flow from the river into the low lands or basins, but all such basins have outlets into the river by which the larger volume of water reenters the river at points lower down. In freshet periods the bed of the river, for miles of its length, has not sufficient capacity to carry the flood waters, the banks overflow, and the low lands or basins become inundated. The works for the closure of sloughs would be expensive to construct, and would require an annual expense for maintenance incommensurate with the benefit to the limited commerce and navigation of the river, and would be almost certain to cause the banks to break at other localities. As an illustration of the cost of works for the closure of sloughs it may be said that at Paradise Cut, which has a width of 220 feet, one was built in 1888 and repaired in 1891 and 1892, at a cost of $19,679, and another, known as Laird Slough, was closed in 1891 and repaired in 1893, at a cost of $19,425.

The amount of commerce carried on the upper river during the calendar year 1899 was reported by the steamboat company to have been practically nothing, owing to low water and drought, yet the records show that between April and August, 1899, inclusive, the steamboats made 20 trips, and in 1900, between May and August, inclusive, made 19 trips. The gauge readings show that from November, 1899, to March, 1900, inclusive, there was never less than 5 feet of water in the upper river, which was ample for navigation purposes, and yet no boats used it. The grain harvest in the San Joaquin Valley generally begins in May and ends in July. If the river is navigable in this period the boats bring some of this grain to market; if not, most of it reaches market by rail. When the river is up there is but little freight to be carried—when the river is low there is too little water for navigation.

The commerce transported on the Upper San Joaquin River, above Stockton, was reported by years as follows:

	Tons.
1896	12,161
1897	13,671
1898	14,091
1899	[1]

The water is used for irrigation purposes to raise crops. Without irrigation it is probable there would be no crops, and hence but little use for navigation. The closure of the sloughs would be of little or no benefit to navigation at low and medium stages of the river, and at high stages of the river the depth of water for navigation is ample, and the closure of the sloughs unnecessary.

The San Joaquin River above the Stanislaus is believed to be unworthy of improvement to the extent of closure of the sloughs.

Respectfully submitted.

W. H. HEUER,
Lieut. Col., Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
October 25, 1900.

Respectfully submitted to the Secretary of War, concurring in the opinion of the local officer that improvement of the locality by the General Government in the manner indicated by the act authorizing the examination is not advisable.

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

[Second indorsement.]

WAR DEPARTMENT,
October 27, 1900.

The views of the local officer, as concurred in by the Chief of Engineers, are approved.

ELIHU ROOT,
Secretary of War.

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[1] Nothing reported.

REPORT OF MR. H. L. DEMERITT, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., September 1, 1900.

SIR: I have the honor to submit the following report of an examination of the—

"San Joaquin River, above the mouth of the Stanislaus River, with a view of determining the advisability of closing the mouths of the more important blind sloughs leading from said San Joaquin River and tributaries, especially those known as Finegan, Amphlet, and Walden sloughs, that the water in the main channel of the said San Joaquin River may be retained therein and more effectually promote navigation thereof."

On August 27 I proceeded from San Francisco to Los Banos, a small town on the railroad, 16 miles from the river, and arrived there at 4 p. m. The next morning I procured a team and guide and drove across the country to Santa Rita ranch, which is on the slough of the same name. There I procured another team and guide and followed the bank of Santa Rita slough to the left bank of the San Joaquin River; then I followed the bank of the river many miles, examined most of the important sloughs, and returned to Los Banos for the night.

On August 29 I went by train to Westley, a railroad station, 2½ miles from Grayson, a small town on the left bank of the San Joaquin River. On August 30 I took a small boat and a man and went down the river 15 miles, past the mouth of Walden, Finegan, Amphlet, and a few smaller sloughs or breaks in the bank of the river. I passed the mouth of the Tuolumne River and near the mouth of the Stanislaus. I returned to Grayson by team, and on the morning of August 31 went up the river several miles, passed Grayson Slough, Laird Slough, and the lower end of Temple Slough, or as it is often called Carpenter Break. This completed my examination of the principal points on the river.

As I had been over the river at high water on a steamboat from Stockton to Firebaugh, and from Hills Ferry to Stockton in small boats, twice in the last four years, I did not deem it necessary to view all of the river again at this time.

The San Joaquin River rises in the Sierra Nevada Mountains, enters the San Joaquin Valley on the east side in Fresno County, and flows in a tortuous course, in a generally northwesterly direction, through the center of the valley.

The principal places on the river are Firebaugh, Hills Ferry, Grayson, and a few unimportant landings, all on the left bank of the river. The main tributaries of the river are the Bear, Mariposa, and Chowchilla creeks above Hills Ferry, the Merced river at Hills Ferry, and the Stanislaus and Tuolumne rivers below Grayson.

The distances on the river in straight lines are about as follows: Mouth of Stanislaus River to mouth of Tuolumne River, 6 miles; mouth of Tuolumne River to Grayson, 4 miles; Grayson to Hills Ferry, 20 miles; Hills Ferry to Firebaugh, 48 miles. To follow the meanderings of the river the distances are about double the above figures.

The Jan Joaquin Valley is nearly level, having a slight fall in the direction of the flow of the river, or 124 feet in about 150 miles. In some parts of the valley the land rises from the bank of the river to the foothills, 10 to 20 miles away. In other parts the land adjacent to the river, from 1 to 5 miles in width, is lower than the banks of the river and is subject to overflow. The general characteristics of the river from Hills Ferry to Firebaugh are the same.

The banks are from 6 to 12 feet high above low water. The width between high-water banks is from 200 to 400 feet. There is a small growth of willows along the banks. The bed of the river is sand and in many places is piled up in large sand bars. The lowlands along the river are cut up by sloughs and waterways, the most important of which are Posey, Temple, Santa Rita, and Middle, 6, 9, 13, and 30 miles, respectively, below Firebaugh, all on the left bank of the river, and through which the water would leave the river. Salt Slough enters the river 6 miles above Hills Ferry, and the waters of the entire basin flow back into the river through it.

On the left bank of Salt Slough, 3 miles up from its mouth, there is a small warehouse. Steamboats occasionly enter this slough at high water to leave freight and merchandise shipped up river, the greater part of which goes by team to Los Banos, a small town on the line of the railroad, 16 miles away. There is no freight shipped out from Salt Slough warehouse.

Firebaugh is a small town on the left bank of the river, and has been considered the head of high-water navigation. It consists of a store, hotel, warehouse, and about three dozen houses. The Southern Pacific Railroad passes within a few hundred feet of the river through the town. Many sheep are sheared here. Wool is the only thing shipped out from this point. The lands are used mostly for pasturage and stock raising. Cattle, horses, sheep, and hogs can not be shipped by boat on account of the long time it takes to make the trip.

Posey, Temple, and Santa Rita sloughs have been closed at their head, and the water in them is controlled by gates and flashboards. Middle Slough and some breaks in the bank of the river are open. High water goes out through these sloughs and breaks and also over the top of the banks for many miles. There are no breaks of any importance on the right bank above Hills Ferry. The banks of the river are alluvial and narrow. If the sloughs and breaks in the bank of the river were all closed, the basin would still fill with water from the overflowed banks and new breaks would be formed.

The lands on either side of the river from Hills Ferry to Firebaugh, from 5 to 15 miles in length, are used for a stock range. Some of the land is irrigated, and hay and corn are raised as feed to fatten cattle. There is none shipped out. From 10 to 15 miles above Firebaugh water is taken from the river for irrigation purposes through canals. The canal on the west side is 40 feet wide on the bottom, 60 feet at surface of water, and 6 feet deep. The water is carried back from the river from 4 to 18 miles and extends 6 miles below Hills Ferry, or a distance of about 75 miles.

The general value of lands above this canal and lower down the valley that are not irrigated is from $5 to $10 per acre, with no purchasers. The value of land that is irrigated is from $40 to $100 per acre, and the productive power of the land is about in the same proportion. I was informed that water was sold to landowners for $2 per acre per year.

Dos Palos and Los Banos are two prosperous towns on the line of the railroad and within the irrigation district. Without irrigation on the west side the country would be very sparsely settled and stock raising would be limited to the river bottom, and then only in favorable years.

Two small canals are taken out on the east side, one above and one several miles below Firebaugh. A railroad traverses the valley on the west side from 3 to 15 miles from the river, and two on the east side from 10 to 15 miles from the river.

Hills Ferry is a place on the river only in name. The small town was all moved to Newman, 3 miles from the river on the line of the railroad when the latter was built. Very little freight is shipped to or from the bank at Hills Ferry.

Ten miles below Hills Ferry, on the right bank, is Temple Slough, also known as Carpenter Break. The banks of the river here are 12 to 14 feet high and extend back 1,000 feet or more. The water has cut a well-defined channel back through this bank, and then spreads out over ground several feet higher than low water of the river. The water from the slough flows down through a small lake and reenters the river over low banks 5 miles above Grayson. A sand bar is formed across the mouth of the cut 5 feet above low water. No water goes out until there is a rise of 5 feet in the river, and it has no effect on navigation.

From Hills Ferry down, the banks of the river are from 12 to 14 feet high and covered with a heavy growth of willow and some oak. The width of the river between the high-water banks is from 200 to 500 feet. The bed of the river is sand, but large sand bars are not so numerous as farther up river.

Grayson is a small town on the left bank of the river, 2½ miles from the railroad. There is one general merchandise store, a half dozen saloons, a dozen houses, and a church at this place. At Westley, the nearest railroad station, 2½ miles from Grayson, there are two small stores and a half dozen houses. Two miles from Grayson, Laird Slough leaves the river and enters the river 2 miles below. The mouth of it was closed off a few years ago by the Government with a weir dam. At first it was built of piling, brush, and sacks of earth. High water damaged it to some extent, and it was renewed with brush and rock. The crest is about 5 feet above low water. It is now in good condition. Grayson Slough is just above and in front of the town. It is a by-pass for some of the high water of the river and is closed off at both ends by sand bars. Some of the high waters go out below Grayson on the left, over the low banks on the Richards ranch. Several small lakes are filled and the water returns to the river lower down.

About 1 mile from the mouth of the Tuolumne River there is a break in the right bank about 50 feet wide, the bottom being 5 feet above low water of the river. The break is of no importance.

One mile below the mouth of the Tuolumne River is Finegan Slough. The banks of the river here are from 10 to 12 feet high, and extend back 1,000 feet, with little fall inland. The break leads into the basin between the Tuolumne and Stanislaus rivers. Its width is from 100 to 150 feet. The low-water surface is from 60 to 100 feet wide and from 5 to 8 feet deep for some distance inland, but there is no water flowing out through it at low water. I was informed by a man living near by that on the first rise of the river water would flow out through the break.

About 600 feet above Finegan is a small slough 30 feet wide, the bottom being 6 feet above low water. Finegan Slough is sometimes known as Walden Slough, but

I was informed by a man living near the place that Walden Slough was some distance up the Tuolumne, on the right bank, and that the waters from it flow into the same basin between the Tuolumne and Stanislaus. The high waters of the river overtop the banks along there in many places. The banks of Finegan Slough are alluvial.

To close the slough by a high dam would cause the high waters to cut other channels out into the basin; to close it by a weir dam would be expensive (costing probably $25,000), with great uncertainty about maintaining it, and navigation would not be benefited.

Two miles below the point where Finegan Slough leaves the river, on the right bank, is Amphlet Slough. It is about 60 feet wide and cut down nearly to low water. A small stream of water runs into the river through it. Whether the water runs in or out at high water, it would have no effect on the navigation.

All the water that leaves the river in any of the sloughs or breaks in the bank returns a few miles farther downstream, so that no water is lost to the river except for short distances, and probably the water flowing from the sloughs and basins helps to keep the water up in the river toward the last of the high-water season, and consequently, if they affect it at all, would benefit navigation.

Below Finegan Slough the river is in good condition; that is, the grade is uniform and there are no sand bars to be scoured out.

The rainy season in the San Joaquin Valley usually extends from November to April, and sometimes later. The waters from the melting snows in the Sierra Nevada Mountains come down the river from April to August. The waters commence to recede about June 15. The low water on the river is from the 1st of August to December or January. At the present time there is very little water running in the river. Above Hills Ferry the stream in places is 10 feet wide and 3 or 4 inches deep. I saw water running in only one slough, and then only a few inches deep. From Hills Ferry to the mouth of the Tuolumne there is only water enough to float a skiff, and many times as I was coming down the river the man pulling the boat had to get out to force the boat over shoal places. The low water is in pools and riffles. The pools are from 500 to 1,000 feet in length, and 40 to 100 feet wide; the riffles are from 20 to 50 feet wide, and from 50 to 200 feet long.

Where the lands are irrigated very little grain is raised, as it is more valuable for other crops. Grayson is the principal point for shipping grain. The valley near that town is cultivated, and the principal crop is wheat and barley. For the past four years small crops have been the rule on account of dry seasons. Lumber, merchandise, and grain sacks are shipped up river; grain, wood, and wool are shipped out.

At the San Joaquin Bridge, 9 miles below the mouth of the Stanislaus River, a water gauge is kept; also the number of steamers passing through the draw going up the river. The number of trips made by steamers up river through the bridge in 1899 was as follows: April, 2 trips; May, 4; June, 4; July, 8; August, 2; and in 1900 as follows: April, 2; May, 3; June, 4; July, 8; and August, 2. The draft of steamers going on this river is from 2 to 3 feet.

I find by reference to the gauge, that in November and December of 1899 there was plenty of water for steamers to go up river; and in January, 1900, there was from 7 to 14 feet; February, from 5 to 6 feet; March, from 5 to 9 feet. For five continuous months, with plenty of water in the river, no steamboats passed through the bridge to go up river.

There is a very limited demand for steamers on the river. The grain harvest in the valley begins in May, and most of it is harvested by the middle of July. During the high water there is plenty of water for navigation and irrigation, and during low water there is not enough for either.

As a result of the examination it was apparent to me that steamers could navigate the river at high water however much might be taken out for irrigation; but that at low water, even if all the breaks and sloughs were closed and irrigation was stopped, there would not be enough water in the river to make navigation possible; that the amount of freight to be carried by boat is small, and limited to about four months of the year during the high-water stage of the river; and that the closure of the several sloughs would be very expensive and of no benefit to navigation. For these reasons I do not consider the San Joaquin River, above the mouth of the Stanislaus, worthy of improvement to the extent of closing any of the sloughs or breaks in its banks.

Respectfully submitted.

H. L. DEMERITT,
Assistant Engineer.

Lieut. Col. W. H. HEUER,
Corps of Engineers, U. S. A.

U U 15.

MODIFICATION OF HARBOR LINES IN SAN FRANCISCO HARBOR, CALIFORNIA.

Board of State Harbor Commissioners,
Office Union Depot and Ferry House,
San Francisco, Cal., September 28, 1900.

Sir: I respectfully request that the existing pierhead line of the harbor of San Francisco be changed to conform with the line indicated on the accompanying map[1] and report[1] of the chief engineer of the board of State harbor commissioners as indicated by dotted lines. Such change will not interfere with navigation. When the pierhead line was established by the United States the commerce of this port was small, and vessels did not require the construction of longer wharves.

The great increase of the commerce of this port, especially under the policy of the present National Administration, is such as to render our wharf facilities barely adequate for the immediate present and wholly inadequate for the near future, and the existing wharves are not of sufficient length to properly accommodate the great ships docking at San Francisco.

As governor of this State, my determination is to provide all the facilities requisite by erecting such permanent structures as will be a pride to the State and a monument to the present national and State administrations. One of the purposes of the late extra session of the legislature, called by me, was to provide means for such permanent and adequate structures without an additional tax on the people of the State or the commerce of the port. The laws were amended to that end and the results contemplated will be accomplished after the pierhead line is extended as requested. Without such extension it is not possible to construct wharves of the length requisite.

An early consideration of this application is respectfully requested.

I have the honor to be, very respectfully,

Henry T. Gage,
Governor of the State of California.

Hon. Elihu Root,
Secretary of War, Washington, D. C.

* * * * * * *

[Fourth indorsement.]

Office Chief of Engineers,
U. S. Army,
November 23, 1900.

Respectfully returned to the Secretary of War.

Application being made for a modification of the existing harbor line of the harbor of San Francisco, the subject was referred for consideration and report to the San Francisco Harbor Line Board.

The Board has carefully considered the application, held a public hearing after due notice to interested parties, and submits the accompanying report, dated the 16th instant, to which attention is respectfully invited.

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[1] Not printed.

The Board expresses the opinion that the present condition of the shipping interest demands piers of greater length than would be permissible under the existing harbor line, and that this condition will best be met by advancing the line along a portion of the water front 200 feet. The Board, therefore, recommends that the existing pierhead line be modified as shown by the broken lines on the accompanying tracing,[1] and described in its report.

I concur in the views of the Board and recommend that the modification be approved, and that the Secretary place his approval upon the tracing and upon the report, which have been prepared for his signature.

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
U. S. Army.

REPORT OF BOARD OF ENGINEERS ON HARBOR LINES AT SAN FRANCISCO HARBOR, CALIFORNIA.

UNITED STATES ENGINEER OFFICE,
PACIFIC DIVISION,
San Francisco, Cal., November 16, 1900.

GENERAL: The Board of engineer officers to consider and report upon the subject of harbor lines of San Francisco Harbor and adjacent waters, has the honor to submit the following report upon the application of the Hon. Henry T. Gage, governor of the State of California, addressed to the honorable Secretary of War September 28, 1900, and referred to it by second indorsement of your office thereon for consideration and report.

The Board deemed it necessary to hold a public hearing, and accordingly one was called, by advertisement in the papers and by notice mailed to all parties known to be interested in the subject, to be held at 10 a. m. of Thursday, November 15, in the office of the State harbor commissioners. There were present the members of the Board, the board of State harbor commissioners, with their chief engineer and attorney, the secretary of the Chamber of Commerce of San Francisco, and their committee on harbor and water front, specially delegated to attend this hearing, and a few others.

The meeting was duly opened. The letter of application for a change in the existing harbor line was read, and the chart showing the proposed modification exhibited. As there was no response to the call for views in opposition to the change, Secretary Scott, of the Chamber of Commerce, briefly stated the changed conditions of the commerce of the port since the establishment of the present pierhead lines in 1888, and showed that the facilities were totally inadequate for the present shipping and the great increase that was anticipated in the near future, consequent upon the growing trans-Pacific trade.

Mr. Harney, of the State harbor commission, explained that the facilities at that end of the harbor were inadequate to meet the demands of traffic; that the present length of piers did not afford accommodation for the large vessels that were now coming to the port; that four new wharves are to be built soon, and it is the desire of the board of State harbor commissioners to have them built out to the line now proposed. After a very thorough discussion, the hearing was concluded.

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[1] Not printed.

With the report of the hearing are submitted letters[1] dated November 8 and 12, of Mr. Chas. S. Neal, president of the North Central Improvement Association, and of Mr. E. Scott, secretary of the Chamber of Commerce of San Francisco, all that have been received in response to our invitation.

The Board finds an entire unity of sentiment in regard to the proposed change in the existing harbor line, and no reason why the change should not be authorized. The existing pierhead line was established in 1888 and conformed to the law of the State at that time, which limited the piers to a length of 600 feet from the sea wall, and the provision was ample for the accommodation of shipping. The present changed conditions demand piers of greater length, or more piers. It appears to the Board that the conditions will best be met by advancing the harbor line along this portion of the water front 200 feet, thereby allowing the construction of wharves 800 feet long. No appreciable encroachment will be made upon the anchorage area of the harbor, or upon its tidal volume, nor will navigation or shipping facilities be otherwise than benefited.

The Board therefore recommends a change in the existing pierhead line of the harbor of San Francisco to conform to the following description:

Beginning at a point in the northerly prolongation of the westerly line of Van Ness avenue, distant 1,000 feet from the intersection of the southerly line of Lewis street with the westerly line of Van Ness avenue (the latter being a point in the inner line of the sea wall and thoroughfare); thence along straight lines parallel to the said inner line of the sea wall and thoroughfare to the foot of Lombard street; thence along a straight line drawn through the outer ends of perpendiculars, one erected at the northerly end of the inner line and thoroughfare, between Lombard and Filbert streets, 1,000 feet long, and the other a perpendicular erected at the southerly end of the inner line between Mission and Folsom streets, 800 feet long, to junction with the existing pierhead line. Each parallel so forming the harbor or pierhead line to be extended to the intersection with the succeeding parallel, and to terminate at such intersection, as shown in broken lines on tracing accompanying application.

Respectfully submitted.

S. M. Mansfield,
Colonel, Corps of Engineers,
Senior Member.
W. H. Heuer,
Lieut. Col. Corps of Engineers.
Chas. E. L. B. Davis,
Major, Corps of Engineers.

Brig. Gen. John M. Wilson,
Chief of Engineers, U. S. A.

[First indorsement.]

War Department,
December 4, 1900.

The within recommendation of the Board is approved.

Elihu Root, *Secretary of War.*

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[1] Not printed.

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